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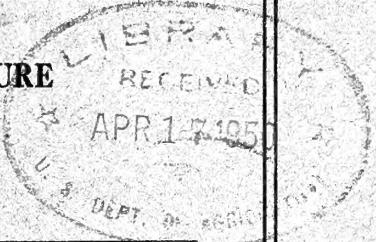
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FOREST RESEARCH ACTIVITIES

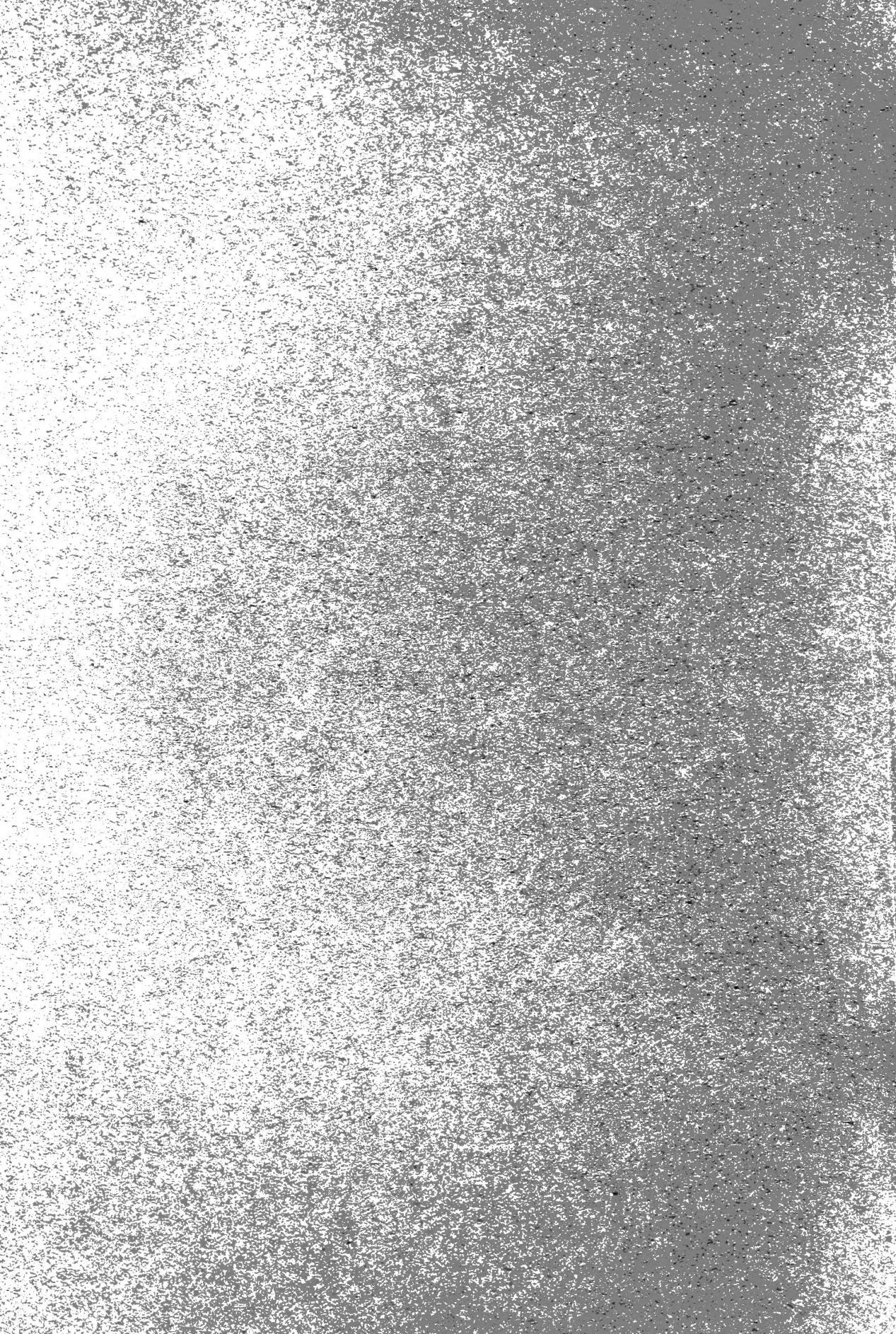
FOREST MANAGEMENT
WATERSHED MANAGEMENT
FOREST PRODUCTS

FOREST ECONOMICS
RANGE MANAGEMENT
FOREST SURVEY



October, 1938.





FOREST RESEARCH
BI-MONTHLY REPORT

October 1, 1938

NOTICE

During the summer the opinion of the Field as well as the Washington Office was requested on the advisability of reporting upon current research bi-monthly instead of monthly. There was an almost unanimous agreement on a bi-monthly schedule, omitting the summer months as usual. Therefore, beginning with this issue, the "report" will appear bi-monthly as of October 1, December 1, February 1, April 1 and June 1.

FOREST RESEARCH

BI-MONTHLY REPORT

October 1, 1938

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GENERAL

Allegheny

Personnel. The demand for men with some experience for Flood Control Surveys resulted in the transfer of Assistant Silviculturist Wood to the Central States Station where he will be Forest Service representative on the Muskingum Basin survey. Senior Economist Bevan assumed charge of the Flood Control Surveys in the entire Northeast, including New England and New York.

Junior Forester Ostrom left for the Yale Forest School to study for his Master's degree. Field Assistant Niederhof is studying for the same degree at Harvard. H. M. Galloway joined the F.C.S. staff as Field Assistant, and M. J. Harding is Field Assistant at Kane. Junior Forester Meyer transferred to the Flood Control Surveys.

Cooperation and Public Relations. Our relations with the State forestry services have been substantially advanced by New Jersey's promise of \$1500 of cooperative funds for fire studies, and by a considerable exchange of information between the Pennsylvania Department of Forests and Waters and the Station; a number of Pennsylvania men studied our Kane experiments extensively, and Hough spent several days in Sullivan County as consultant in the establishment of T.S.I. demonstrations for future CCC guidance.

A two-day conference on joint research programs was held at the Standing Stone and Kane branches with the Pennsylvania State College, Dean Watts, Experiment Station Director Fletcher, the forestry faculty, and Dr. Bennett, in charge of the new wildlife research now underway through cooperation of the Bureau of Biological Survey and the Pennsylvania Fish and Game Commissions with the College. Dr. Merkle of Penn State, appointed as collaborator, spent some days at Kane in soil studies, and Forestry Extension Specialists Murphey and Simonds paid a two-day visit there for discussion of common problems.

The Station cooperated with Region 7 in clarifying the forestry situation in the Station territory to Granger and Pierce, on integrated inspection from the Chief's office. Forbes and other members of the staff travelled with the party over the region.

Contacts with the Northeastern and Appalachian Stations, through visits to our territory by Stickel, Jensen, Jemison, and Snow, have been very profitable, and Hough and Little have learned much through brief visits to the Northeastern Station's territory.

Hough spent a few days with Secretary Haertel of the Wood Chemical Institute on various operations of the Institute's members

in the upper Delaware Valley.

Appalachian

Personnel. Dr. R. E. McArdle assumed his duties as Director of the Station July 1, by transfer from the Rocky Mountain Station.

California

Meetings. The annual research meeting of the Station and the Region was greatly delayed by almost continuous absences of Regional Forester Show or Director Kotok, or both, and was not held until June. It was therefore limited to consideration of major policy aspects of a Station program already in progress and proved to be one of the most fruitful and stimulating that have ever been held. The Flood Control work was a sector of particular pressure. Among meetings in this field, one of the most significant was that held at Pasadena with the State Engineer, representatives of the Los Angeles County Flood Control District, and the Division Engineer of the U.S. Army to review the upstream flood control surveys and work plans of the U.S.D.A. At San Dimas a meeting of the Agricultural Commissioners of 11 southern California counties was held to familiarize them with the work there. Inspections by Bernard Frank in August and E. N. Munns in September aided the crystallization of all the work of the Forest Influences Division of the Station. In the Division of Fire Research the work on chemical fire control brought to the Shasta Experimental Forest Mr. T. R. Truax of the Forest Products Laboratory for several weeks' collaboration in this research. The purchase by the California Region of the first fire service airplane to be owned by the Forest Service started cooperative experimental work in dropping fluids upon fires. In Range Research the summer period was signalized by completion of the Western Range Survey of three California counties. A two-weeks' inspection of the Range Division's work by Chapline in September was a high-pressure overhauling from which the Division personnel are now convalescing. Harper spent about two weeks at the Station reviewing work programs in forest management with particular attention to silviculture and genetics. At a meeting of the Pacific Southwest Regional Planning Conference at Santa Barbara in early September, a paper by Director Kotok, "Regulating Uses of Private Land an Essential Function of Modern Government", was read in his absence.

Visitors. A pleasant incident of the summer was a week's visit by Dr. Göte Turesson, Director of the Institute of Plant Systematics and Genetics of the Agricultural College of Sweden, at Upsala. The purpose of his visit was to arrange for seed collection from the principal forest trees of the Pacific Coast. This project is made possible by a fund of 400,000 Kronor donated by a banker of

Stockholm through the efforts of Crown Prince Gustav Adolph of Sweden, for the establishment of a tree-breeding station at Svalöv, the Director of which is Dr. Nils Sylvén.

Central States

Personnel. The initiation of detailed watershed surveys has required the addition of several employees. O. M. Wood was transferred on August 25 from the Allegheny Forest Experiment Station to represent this Station on the detailed survey of the Muskingum River in Ohio.

Professor LeRoy Tucker was employed on June 13 to assemble data for the preliminary report on the Gasconade River, Missouri. He collected geologic data for the St. Francis River, Missouri, above Wappapello Dam, for purposes of the proposed detailed survey before the completion of his employment on August 2.

Professor F. K. Beyer was engaged from June to September to assemble data on the White River, Ark. and Missouri. Thereafter he collected hydrologic data for the detailed survey of the St. Francis River, Missouri, above the Wappapello Dam.

Forest and Land Survey, Reynolds County, Missouri. The station cooperated with the statistical staff of the forest and land survey project at St. Louis, in outlining the procedure for compiling field data on tree defect in accordance with methods used on similar studies elsewhere in the region.

Visitors. Miss Lillian Villand, of the Library staff of the Washington Office of the U. S. Forest Service, visited the Station in July, and commented favorably on the work of the Station Library, and made several helpful suggestions for improving the library procedure.

Dr. Larrimer conferred with Day early in July on Flood Control personnel and general station administration.

E. N. Munns of the Washington office spent a portion of August 25 and August 26 at the Station discussing flood control and other matters with Day and the staff.

Intermountain

Personnel. C. Kenneth Pearse has been transferred to the Artificial Reseeding project. He will take up the work where Dr. R. H. Walker left it last April.

Lake States

Field Demonstrations. As time elapses and the results of forest treatment become apparent on the Station's experimental forests, a greater and greater use is made of these areas for demonstration purposes. Literally hundreds of persons visit the branch stations each summer, ranking all the way from governors through professors of forestry and directors of forest experiment stations down to school children.

That such demonstration work takes a considerable amount of time there is no question. But is it worth while? This Station believes that it is, especially in the present stage of forestry development. Our field stations are becoming known and appreciated by a fairly wide cross section of the local people--and it is through such contacts that results gradually get into use. Moreover, it gives the various station members valuable experience in learning how to put over their "stuff" and to deal with the public.

Northeastern

Hurricane of September 21. Farnam House, in which the Station is housed, and the Farnam Memorial Botanical Garden surrounding the building, were within the area in New Haven that experienced the severest force and suffered the greatest damage in the hurricane of Wednesday afternoon, September 21. Although the loss to the building was slight, consisting of several broken windows and a chimney that was knocked down by a broken tree top, the damage to the trees in the Botanical Garden was so extensive that the grounds resembled a miniature "blow-down." A total of 27 trees, ranging in diameter from 7 to 38 inches d.b.h. were destroyed. Of these, 17 were uprooted, 5 were broken off several feet above the ground, and 5 had tops so badly broken that they will probably have to be cut down. In the Garden, in general, tulip poplar was the species that was affected most severely by the combination of soft ground due to the previous rainy spell and the high winds of the hurricane.

The hurricane tore a swath through New England as a climax of four days of heavy rain. More than $7\frac{1}{2}$ inches of precipitation were recorded at our Gale River and Hopkins Memorial Experimental Forests and more than 6 inches fell at Bartlett Experimental Forest. Thus, when the hurricane struck, the ground was so soggy that entire stands went down before the wind.

The breaking up of cloud masses and the appearance of blue sky shortly after noon of September 21 in the vicinity of the Gale River Experimental Forest proved to be but a lull in the violent

rainstorm that started on the nineteenth. A showery condition prevailed the remainder of the afternoon; it began raining again at about six o'clock. Next the wind began to rise. By seven o'clock the wind was blowing with sufficient force to bend shade trees in the vicinity of the dwelling at a dangerous angle. Westveld states that few trees were uprooted prior to seven-thirty p.m. Most of the breaking and uprooting occurred between eight and nine o'clock, at which time the wind was blowing with hurricane force from the southeast. Practically all of the down timber for a radius of some fifteen miles around Gale River pointed toward the northwest. In general, trees were windthrown rather than broken.

Over six inches of the 7.53 inches of precipitation which occurred during the storm fell prior to the blow. Examination of the forest floor on the afternoon the 21st showed all depression and pockets in the bench country on the Gale River Forest full and overflowing, creating a temporary swamp condition. In effect, the forest in these flats and benches stood in a sea of mud. Stands on such sites were unable to withstand the force of the wind when it assumed gale proportions and were flattened to the ground like fields of wheat before a driving rainstorm. Like skiffs with too much canvas, large-crowned hardwoods still in full leaf were overturned by the hundreds, often carrying with them numbers of under-story conifers.

Observations of run-off made currently by our Flood Control party on the Merrimack River indicate that in the forests the ground was taking precipitation well until the fourth day. Serious flood stages did not seem likely until the last day of the storm when all of the precipitation appeared to run off. The resulting flood approached that of 1936 in severity. On some streams such as the Deerfield River in Massachusetts, the crest was reported well above that of 1936, but the havoc wrought by the hurricane has overshadowed the severity of this flood of major proportions.

Losses in general were heavier in treated stands where cuttings robbed the mutual protection a many-stemmed stand affords than in untreated stands. Natural or artificial openings in a stand, forest roads, etc., provided the avenues of entrance through which the wind raced to lay flat areas ranging from 50 to 100 feet in diameter to many acres in extent. The storm's vagaries probably account for such freak occurrences as wrecked and undisturbed stands almost adjacent to treated stands showing only moderate loss.

The loss on the Gale River Forest is estimated at a minimum of 3,000 cords. On the basis of a total growing stock of 30,000 cords, this represents an overall loss of only 10 percent. However, the loss was not evenly distributed over the forest but was concentrated on high-value areas. For example, the 100-acre ex-

perimental tract of partial cutting in second growth spruce is completely demolished. Not only are the 1,200 cords of residual growing stock practically wrecked, but the experimental value of the tract with its heavy accompanying investments has been irretrievably lost. Also, the treated 120-acre sawtimber compartment with its numerous permanent sample plots has suffered very heavy losses. The extensive loss in second growth spruce areas leaves practically no further stands of this character available for repeating the sawtimber management and partial cutting experiments. Since the development of a technique for successful management of second growth spruce stands constitutes an outstanding problem in spruce management research, consideration should be given at once to the possibility of acquiring somewhere in the region a fairly extensive tract of second growth spruce for further experimental work in this field.

The Bartlett Experimental Forest was also hit heavily with the loss estimated at 3,600 cords or almost five percent of the stand on 2,600 acres. The Massabesic Experimental Forest, Alfred, Maine, lying to the east of the storm path, suffered only slight loss. Similarly, on the Hopkins Memorial Forest, in Williamstown, Massachusetts, to the west of the storm path, windfall was not abnormal but some damage was done by high water.

The overall figures of damage do not tell the tale with respect to research work. A large part of our investment in long-term experiments has been lost. A 100-acre partial cutting experiment in second growth spruce on the Gale River Forest is a total loss. The spruce thinning plots established in 1932 will have little further value. Selective cutting plots in a 100-year old stand of spruce on the Dartmouth Trail on Cherry Brook are also a complete loss. At Bartlett all of the partial cutting and thinning experiments have been severely hit. We have yet to ascertain the extent of damage on a large number of permanent sample plots which lie in the path of the storm at such points as Waterville, Corbin Park, Peterboro, and Manchester, New Hampshire; Green Mountain National Forest and the L. R. Jones State Forest, Vermont; and Willimantic, Connecticut.

In order to meet this situation we plan to make a quick survey of all losses before snow flies as a basis for re-orientation of our entire program in silvicultural research during the winter. Second, we will make every effort to salvage the down timber and clean up the experimental forests, either by sale or C. C. C. projects during the fall and winter. Finally, it will be necessary to make a complete re-inventory of both the Gale River and Bartlett Experimental Forests and to re-tally all of the permanent sample plots in the storm area next spring.

Meetings. During the early part of September, Stickel arranged a fire inspection trip through the southern part of the region for Little of the Allegheny Station, and Messrs. Seidel and Davis of the New Jersey State Forest Fire Service. After visiting Cape Cod to see some of the latest developments in water-hole and fire line construction as well as tank trucks, the group joined the annual conference of the New England Forest Fire Wardens Association in New Hampshire. At one of the evening meetings of the conference, Stickel was given the opportunity of discussing the recently completed fire detection study on the White Mountain National Forest.

Northern Rocky Mountain

Reports and Meetings. Acting Director Bradner spent a considerable portion of July and August on Joint Congressional Committee reports and meetings. The Station furnished most of the statistical data for the Idaho-Montana portions of the regional reports. Bradner sat in on most of the meetings at Missoula and Portland and was present at the sub-congressional committee hearing at Sun Valley, Idaho.

Ground work in preparation for two joint public hearings on flood control and attendance at meetings of flood control committee 23-A occupied a considerable portion of Bradner's time during September.

Visitors. Mr. Chapline spent two weeks with staff members of the Station during late August and early September on range and general station inspection work.

Pacific Northwest

Personnel. Material changes in organization took place at the Pacific Northwest Station during the summer season, 1938. Thornton T. Munger, upon his own request, transferred on July 1 from his executive job as director to technical work as chief of the Division of Silvics at this Station. Stephen N. Wyckoff transferred on July 1 from director of the Northern Rocky Mountain station to director of the Pacific Northwest. Early in August, H. J. Andrews, who had organized and was in charge of the Forest Survey, left Portland to take up a research professorship at the University of Michigan. R. W. Cowlin is now acting in charge of the Survey.

Visitors. Several prominent visitors called during the summer months, among whom was Dr. Gote Turesson, Director of the Institute of Plant Systematics and Genetics of the Agricultural College of Sweden at Uppsala.

Southern

Annual Investigative Meeting. The Annual Investigative Meeting was held on the Olustee Experimental Forest, June 15 and 16. The meeting this year considered only the program of the Division of Silvics and of the cooperating Forest Pathology and Biology projects. In attendance were Regional Forester Kircher and 11 of his Associates, Assistants, Supervisors, and Rangers; Director Demmon and 11 men from the Station; 5 men from the Alabama, Georgia, and Florida State forestry organizations; and a representative of the University of Florida forestry school. The proposed program for each project was presented by the man in charge, and this program was discussed first by previously selected leaders and then by the entire group before taking up the next project. These presentations and discussions occupied two morning sessions and field trips over the Olustee Experimental Forest occupied the afternoons. At the conclusion of the two-day meeting, small committees appointed at the sessions reviewed each project program and presented specific recommendations as to the suitability of each program, the priority of separate studies, and similar points. The minutes of the entire meeting, including presentation of program, discussion, and committee reports, were later mimeographed and distributed to those in attendance and to interested persons who did not attend. It was generally agreed that the entire meeting was one of the best of its kind ever held in the South.

FOREST MANAGEMENT

SILVICULTURE

Allegheny

Thinning Plots in Birch-Beech-Maple-Hemlock. The five-year remeasurement of eight acres of thinning plots at Kane was nearly completed. The measurement includes diameter and height changes in the residual stands and reproduction tallies. This series of plots was established to determine the possibility of stand improvement resulting from the removal of about one-third the volume in 40-year old stands. The severe glaze storm of 1936 injured trees on all plots and has permitted an evaluation of the effect of this treatment on susceptibility to glaze breakage and other damage.

Percentage of total basal area of trees
2" d.b.h. and over severely damaged by
glaze in March 1936

Plot	Area (Acres)	Percentage of damage	
		Check	Treated
1	2	16.6	52.8
2	2	38.6	56.4
3	4	42.9	42.0

Conditions in Plots 1 and 2 plainly indicate the need of caution in thinning young stands on exposed locations, such as a plateau top. On Plot 3 the stand is chiefly a black cherry-yellow birch mixture in which the chief species damaged on both check and treated plots was black cherry.

Prolific sprouting from black cherry stumps is frequently a serious problem in third-growth stands of northern hardwoods on the Allegheny Plateau. Peeling of stumps, girdling of stumps, and de-sprouting midway of the second season have been compared as methods of sprout-prevention on one of our timber sales. The first two methods took 12 to 15 times as long as the last, and were only partially effective; it is too early in this particular experiment to judge the effectiveness of the de-sprouting, but on other areas it has been great with black cherry, less with the maples.

The establishment report has been completed for the so-called shelterwood cutting in glaze-damaged timber. The experimental plots were laid out in a culled virgin stand where cutting had resulted in very abundant advance reproduction; the present operation approximated a second, or final, removal of the overwood. Logging damage to the young growth, its subsequent development, and the effect of moving it back are under observation.

Thinning in Virginia Pine. The establishment report was completed for the C.C.C., T.S.I. thinning demonstration in Virginia pine in southern Maryland. Tentative conclusions based on rather scanty information, fortified by considerable observation, are:

1. Thinning of even a moderate intensity in young Virginia pine stands (15 years old) having a stand density index of 100 or more, with an average diameter of two and five-tenths inches, renders the

residual trees susceptible to bending or leaning from snow and ice damage. (Stand density index of 100 is 3000 trees at two inches, 1600 trees at three inches, 730 trees at five inches, and 250 trees at ten inches).

2. Thinning in stagnant stands - stands that are growing on poor soils and that have a stand density index greater than 100 should be undertaken in three cuttings. The first cutting, at 10 years, reduces the number of trees to 1300-1500 per acre; the second cutting at 15-20 years should reduce the number of trees to 900, and the third cutting at about 25 years.
3. When the average stand diameter at 15 years is greater than 2.5 inches (d.b.h.) the following thinning is recommended for the listed stand density index values.

Stand Density Index (Chart 1)	Recommended Crop Tree Density at 15 years. (Trees per Acre)	Time of 2nd Thinning-Age of Stand.	Estimate of Average Stand d.b.h. at Time of 2nd thinning (Conservative)	Crop Tree Density after 2nd Thinning (Trees per Acre)	At 35 years the estimated d.b.h. will be
60-80	700	30	6-7	500	7-8
81-100	800	25	5-6	600	7-8
100-120	900	20	3.5-4.5	700	7-8

4. The ability of suppressed trees in the 25 and 30 year old stands to overcome the effects of suppression seems doubtful. The advisability of thinning in these stands will be determined after a few years have elapsed.
5. The increased time involved in marking areas for cutting does not appear justified in view of uncertainty as to an adequate intermediate cut. This situation may not be true on a farmer's woodlot where the operation of

selection and cutting is carried on simultaneously. Where the marking of crop trees and trees to be removed is conducted as a separate operation from cutting, additional time is consumed.

Seed Bed Conditions for Shortleaf Pine. Wood's study of seed bed conditions for shortleaf pine, begun at the Lebanon Branch in the summer of 1936, to date shows that mere raking of leaf litter from an experimental area resulted in no significant increase in shortleaf pine reproduction, whereas digging of the seed bed, or scalping (and removing) the turf layer of matted roots of lesser vegetation, increased some three to five times the germination on an undisturbed plot. Data from small screened areas, artificially sown, compared with those from unscreened adjacent areas, show clearly the large amount of seed consumed by animals and birds, and indicate that digging or scalping create conditions less favorable to small seed-eating rodents.

Appalachian

Harvest Cuttings in Cove Hardwoods. Cutting studies on a relatively large scale in second-growth stands of the cove hardwood types were begun in August with the establishment of a 4-block - 24-plot experiment on the Fernow Experimental Forest in West Virginia. Since second-growth stands of cove types beginning at 25 to 30 years of age are becoming increasingly valuable for their pulpwood stumps, cutting-method experiments which combine the removal of pulpwood with measures calculated to safeguard future timber values are essential. As has been the case with similar stands, logging on the Fernow area left holdovers of beech and hard maple, many of which are now merchantable. Stand treatment will consist first of removing these holdovers and then of making different types of thinnings in the 30-year-old understory. The basal area of the holdovers varies from 0 to as much as 35 square feet per acre. The 24 plots have been divided into four groups on the basis of the basal area of holdovers, and the six treatments listed below have been assigned at random to the plots in each group.

1. No treatment
2. Cutting holdovers
3. Cutting holdovers with light thinning from below
4. Cutting holdovers with heavy thinning from below
5. Cutting holdovers with light thinning from above
6. Cutting holdovers with heavy thinning from above

Thinning from below will be in the nature of a salvage cutting of such trees as would probably die before the end of the rotation, while thinning from above will yield a considerable immediate cash

return by removing the largest and best trees. Pulpwood species cut in the thinnings will be sold for pulp. Unmerchantable species and holdovers too defective to sell will be cut, corded up, measured, and used for fuel.

Harvest Cuttings in Hemlock. Brief observations made during the summer on the selective cutting areas established four years ago at Bastian, Virginia, showed extremely heavy mortality of the residual stand in the hemlock type. The loss was estimated to be at least 60 percent of the merchantable residual volume left after logging. Inspection of three additional areas in Region 8 also showed very heavy mortality following a partial opening of the stand. Present indications are that unless an operable cut can be provided by removal of not over 15 to 20 percent of the volume in the largest trees, clear cutting in the hemlock stands will be advisable.

Observations were also made during the summer on the six-acre Aaron's Run tract near Parsons, West Virginia. This stand, in the cove hardwood type, is an excellent example of sawtimber second growth. The cutting made during the winter of 1934-35 removed 41 percent of the trees and 50 percent of the basal area, leaving a stand of 31.73 trees per acre, ranging from 10 to 20 inches in d.b.h. Yellow poplar and northern red oak are the predominant species in the residual stand and immediately after cutting residual trees of these species had an average clear stem length of slightly over 2-1/2 log lengths. Although observations made at the end of the first growing season showed very little reduction in clear stem length due to "feathering out", by the end of the fourth season a reduction in clear bole amounting to approximately one log length had occurred.

Harvest Cutting in Loblolly Pine. The adoption of pulpwood cutting rules by industry and the increase in value of pine second growth due to the recently developed wood market has opened up new silvicultural problems in the pine types. During the summer a project to compare the adequacy of the present pulpwood cutting rules adopted by industry with more conservative practices was begun. Treatments to be tested are as follows:

Seed tree cuttings:

1. Clear cutting to 5.0 inches d.b.h., leaving 4 seed trees, 9.0 inches d.b.h. or larger, per acre
2. Same as No. 1, only leaving 12 seed trees
3. Leaving 40 of the straightest and best dominant or co-dominant trees, 5.0 inches d.b.h. or larger, per acre

Partial cuttings:

4. Clear cutting to 7.0 inches d.b.h.

5. Light thinning from below to maintain merchantable volume growth, leaving 160 to 200 trees, 5.0 inches d.b.h. or larger, per acre
6. Heavy thinning from below to maintain and increase merchantable volume growth, leaving 80 - 120 trees, 5.0 inches d.b.h. or larger, per acre

In the above list, treatments 1 and 4 approximate alternate rules now adopted by Groups 1 and 2 of the Southern Pulpwood Association. Treatments 5 and 6 were adopted from thinning standards recommended by the Southern Station.

Treatments 1 to 3 are designed for application to stands in which the major purpose is to produce successive pulpwood crops on a short rotation, while treatments 4 to 6 are designed for application to stands in which the major purpose is to produce saw timber, poles, piling or other high value products, pulpwood being produced from intermediate cuttings.

Observations on all treatments will be the periodic yield in (1) total volume, (2) the volume of various products resulting from the several treatments, and (3) the comparative costs and returns per acre as influenced by treatment. In addition to these, the efficiency of various numbers of seed trees in reproducing areas cut under treatments 1 to 3 will be determined.

The experimental design requires that 6 blocks with 2 plots of each treatment in a single block be established in loblolly pine stands 20 to 35 years of age and having a volume of at least 10 cords per acre.

Thus for this season 3 blocks have been established and marked for cutting. Two of these are on national forests and one on Duke Forest.

Mortality in Mountain Hardwoods. In the Appalachian region, particularly for the hardwood types, where reliable growth estimates are based upon the projection of present stand tables by means of diameter growth curves, the determination of periodic or annual mortality is essential to accuracy.

Although a variety of methods for mortality determinations are in current use, the problem boils down primarily to development of a procedure for estimating how long a dead tree has been dead.

During June and July permanent growth plots established in 1933-34 were examined and all trees which had died since plot es-

tabishment were described in detail. During this work it was found possible to set the year of death for a small percentage of dead trees not on plots. This was done by observing on increment cores the period of accelerated growth shown by trees formerly suppressed by the dead tree. In the analysis a number of regressions were run, correlating years since death with a number of characteristics descriptive of dead trees. For hardwoods the relationship giving the highest correlation coefficient and lowest standard error was a simple one between years since death and the percentage of bark left on the lower five feet of the tree bole. Establishment of this relationship provides criteria for mortality determinations somewhat easier to apply than the most common one in current use which is based upon the average size of broken limbs, where size is estimated at the point of breakage. This relationship was also found to be significant but instead of using the average size of all broken limbs, the estimated average diameter of the three largest broken limbs in each dead tree crown was used because of more ready field application. In both relationships d.b.h. was not found to be a significant factor. For the yellow pines there was no significant relationship between years since death and percentage of bark left on the lower five feet of the bole. However, a significant correlation exists between the average diameter of the three largest broken limbs and years since death. Here d.b.h. was found to be a significant factor.

Although most of the hardwood sample trees obtained were oaks, graphic comparisons between curved data for oaks and other important commercial hardwoods disclosed no marked differences. A tabular summarization of the data is given below.

Hardwoods (Primarily Oaks)

Years since death	Av. percent of bark left on lower 5 ft. of bole	Av. diameter of 3 largest broken limbs in crown (estimated at point of break)
1	100.0	0.0
2	100.0	0.1
3	100.0	0.3
4	99.5	0.6
5	98.0	0.9
6	95.5	1.4
8	88.0	3.1
10	70.0	*
12	6.0	
14	0.0	

*Beyond 8 years the curve becomes very nearly horizontal, and distinct correlations of years since death with diameters of broken limbs cease.

Yellow Pines (Primarily Shortleaf)

Years since death	D.b.h. class - inches					
	4	8	12	16	20	24
	Average diameter of 3 largest broken limbs (measured at point of break) 1/					
1	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.7	1.4
3	0.0	0.1	0.6	1.4	2.1	2.9
4	0.7	1.5	2.1	2.8	3.6	4.3
5	2.2	2.9	3.6	4.3	5.1	5.8
2/ 6	3.7	4.4	5.1	5.8	6.6	7.2

1/ Wherever the main leader was broken, its diameter was estimated as one of the 3 largest broken limbs. Breaking off of the main stem occurred frequently in the smaller d.b.h. classes.

2/ Very few pines were found standing 6 years after death.

Pruning. An analysis of two years' growth of pruned white pine indicates that live pruning which has little or no effect on height growth will reduce diameter growth if too

large a percentage of the living crown is removed. The study was made on the Toccoa Experimental Forest in north Georgia, trees 16 to 20 years old, 2 to 7 inches d.b.h., and 15 to 48 feet high being used. The treatments listed below were assigned to 4 trees in each of 90 blocks so that each treatment occurred once and only once in each block:

1. Check trees - no pruning
2. Light pruning - 6 to 15 percent of the living branch whorls removed.
3. Moderate pruning - 16 to 25 percent of the living whorls removed.
4. Heavy pruning - 26 to 35 percent of the living whorls removed.

Data on d.b.h. and height growth during the first two growing seasons following pruning were treated by the method of analysis of variance, differences in original d.b.h., height, and crown ratio being eliminated by covariance. This analysis showed that the diameter growth of heavily pruned trees was significantly less than the growth of trees treated in any other way, but that the diameter growth of check trees did not differ significantly from that of lightly or moderately pruned trees. With respect to height growth there were no significant differences between the four treatments. Average growth, after adjustment for original d.b.h., height and crown ratio, for each of the four treatments is given below.

Kind of pruning	Average growth of 90 white pines during 2 growing seasons	
	Diameter (Inches)	Height (Feet)
None	0.34	3.2
Light	0.34	3.3
Moderate	0.32	3.2
Heavy	0.29	3.1

These results have been summarized in a technical note to be issued by the Station.

Herbarium. During May and June approximately 300 plant specimens were mounted and added to the Station's herbarium. The mounts already in the collection were repaired and new covers were made for them. The work was done by three E.R.A. girls, trained by Mrs. Josephine Thompson from the Division of Range Research in the Washington Office, who was on detail in Asheville for three weeks. A technical note listing the 562 species and varieties in the herbarium at the end of this work was prepared. About 120

specimens collected in 1937 in the Piedmont region are yet to be added to the herbarium. This summer's collections made throughout the Station's territory will probably add another 100 or 150.

California

Pine Region: Blacks Mountain Sustained Yield. Experimental cutting at Blacks Mountain was completed for the season on September 29. The cut amounted to 1,634 M B.M., mostly from salvage-insect control treatments. The first block of 4 plots in the supplementary methods-of-cutting study also was established. A similar block will be established in each of the next 9 years. The treatments compared are Standard Forest Service, modified (lighter) Forest Service, and the treatment being tested on the major portion of the Experimental Forest.

The Forest Practices Committee of the Western Pine Association held its annual meeting at Blacks Mountain Branch September 8 and 9. About 60 lumbermen, foresters, entomologists, and pathologists viewed the methods-of-cutting demonstration plots and the preliminary salvage-insect control logging. The interest of the lumbermen was evidenced by the decision for appointment of a subcommittee of the Forest Practices Committee by Chairman R. A. Colgan, to insure close cooperation between the industry and the Station in conduct of the Blacks Mountain project.

Natural Reproduction. Routine observations of site factors, seed crops, seedling incidence, survival, growth, and root development at Stanislaus Branch revealed nothing unusual. Very few seedlings were established in the spring and a light seed crop gives no better promise for 1939. About 1,000 new seed traps were constructed but were not placed because of the practical failure of seed. A model trap was constructed that will admit entry of large sugar pine seed and insure complete exclusion of mice - it is hoped.

Redwood Region. Field work in the redwood region during the past summer was limited largely to the reexamination of previously established plots and the completion of the redwood logging cost studies for Mendocino County. The two field assistants available for part of the summer were used to advantage on redwood bark peeling studies and in the taking of tree measurements for the redwood volume tables. Field work on the Mendocino County studies of felling, peeling, and bucking is now completed and considerable progress has been made on the analysis of the data by means of a WPA project which was carried on through the summer.

Of particular interest on the Henry Creek natural repro-

duction quadrats is the radical change in the vegetation during the three years since the area was logged. The early fireweed type, composed principally of Erechtites spp. and Sonchus, is being rapidly replaced by later and taller herb species, and particularly by Whipplea, a very aggressive vine-like herb, and by salal, oxalis and other typical redwood-type species. The establishment of redwood reproduction continues to show up very well. Total stocking amounts to approximately 90 percent with nearly 40 percent stocking of seedlings six inches or more in height, most of which have now lived through three growing seasons.

The trees on the 96 planted redwood plots which were established in 1937, were remeasured in July and early August. Although several of the planted redwoods and Port Orford cedars, which are now from 12 to 14 years of age, were over 25 feet in height, there is wide variability in rate of growth even on adjacent areas and many of the trees are still overtapped by shrubs or hardwoods. Very little damage from rodents or other causes was noted on these plots during the last year. Rodent damage in particular was much lighter than in the preceding year.

Central States

Iowa Tree Defect Study. The compilation of data for the Iowa tree defect study was completed at Ames during May. Tabulation of records from over 600 trees cut and examined on 12 sample plots disclosed a cull percent (based on merchantable cubic feet) ranging from a total 6.2 percent for small sizes to 8.5 percent for merchantable trees. Decay from fire scar injury was insignificant in saplings and small and large poles, while in merchantable trees such decay comprised the major loss. Insect injury and miscellaneous losses (the latter including mechanical injury, crook, etc.), caused the greatest loss in all small size classes. A report on this study is being prepared as a cooperative publication by the Station and the School of Forestry, Iowa State College. Kuenzel and Genaux have completed the first draft of this manuscript entitled "Some Defects in Oak Hickory Forests of Southeastern Iowa Which Influence the Yield from Present Stands."

Acorn Study. A preliminary study of the 1937 crop of acorns remaining on the ground after October on the Clark Purchase Unit indicates some interesting leads. The study gave no information on the number of acorns carried away or the viability of the sound ones present. However, it did reveal that over 98 percent of the 6,000 acorns collected beneath 150 trees of white, post, black, scarlet, and black jack oak were defective. Over the area concerned there were about 200 sound acorns per acre. The majority of the damage was caused by insects. Although the data are too few to be significant there was no evidence of any great difference between

trees of species, age, size, density of stand, and size of crown. Of the trees examined, those on the north slope had fewer acorns per acre and the acorns were less defective than those on other exposures. Also the trees on good sites yielded more acorns per acre and they were less defective than those on other trees on poorer sites.

Effect of Fire on Oak Reproduction. Arend and Finley re-examined the two blocks of plots in the preliminary light burning study on the Gasconade Unit in Missouri. The data have been analyzed by Arend and are to be released soon in an informal report. The two fires, one extremely light and the other lighter than the average spring fire in Missouri, killed over 83 percent of all reproduction and injured another 6 percent. The white oaks were more severely injured than the less desirable black oaks. The average depth of litter around the trees that were killed was 1.64 inches whereas around those uninjured trees it was only 0.65 inches. All trees with no litter around them survived. The less desirable black oaks sprouted more than white oaks.

Origin of Sprouts. The dissection of 250 additional sprouts of white, post, and black oak, dogwood, black gum, hickory, sassafras, and chinquapin from the Sylamore Experimental Forest disclosed that every one of them had originated from a dormant bud which was initiated when the primary wood of the parent stem was formed. This is additional proof that most if not all of the sprouts from hardwood trees in the forests of the Ozark Uplands originate from dormant buds.

In an effort to find out how many of these dormant buds are present on oaks, a number of girdled trees have been tagged and the sprouts counted and removed periodically. It may be that some sprouts will develop after all of the dormant buds have developed into sprouts and the latter removed.

Response of Reproduction to Release and Sprouting Study. The 60 permanent 1/10 acre plots being used in the sprouting and reproduction release studies have been established and all of the treatments completed. Arend and Finley have started taking data on the sprouting of the trees treated in the various ways and the amount of response the reproduction has made to the different types and amounts of release.

It has been observed on numerous occasions that the reproduction that is present in the Ozarks does not respond to release as well as do the sprouts that develop if the top of the reproduction is cut off. In an effort to get some information on the point and perhaps some leads on ways of getting rid of undesirable reproduction, 1200 individuals in three areas were staked and

their description recorded. One-fourth of these, picked at random, were cut two inches above the ground, one-fourth cut as low as possible, one-fourth jerked off as low as possible and the rest left as checks. At the end of the growing season the amount of sprouting and rate of growth of the sprouts of the tree treatments will be taken and compared with each other and the checks.

Reproduction Study. The main analysis of the data in the reproduction study on the Gasconade has been completed. Similar data from the Clark Purchase Unit are now being analyzed.

Farm Woods. The annual remeasurement of the cooperative grazing and management plots was completed by Field Assistant J. P. Johnson with the assistance of Debrowsky of the Department of Forestry, Purdue University. The third bulletin on these cooperative studies, "The Development of Natural Regeneration in Previously Grazed Farmwoods," came off the press late in August.

Lake States

Light vs. Heavy Cutting in Northern Hardwoods. Ten-year remeasurements of sample plots at Dukes indicate a considerable difference in growth rate and development of young growth between areas cut lightly and those cut heavily or clear cut. In this locality there is a fairly good stocking of advance reproduction. In areas cut ten years ago under a light selection system this advance growth is slowly developing into saplings and small poles; sugar maple is the most numerous species; defects or scars on the boles frequently show signs of decay; there is a definite growing toward the light of some trees which tends to develop "lean" in the tree as it grows older; but a few saplings in each opening seem to be making definite progress toward the timber class. Apparently this is the way the present old-growth stands developed.

On clear-cut areas the growth rate of the saplings is much more rapid; there is a greater variety of species, some good, some inferior, and the trees are generally straighter. There is also a greater preponderance of sprout growth.

This, however, is just a part of the story. The lightly cut areas are also growing from 150 to 250 board feet of merchantable timber each year whereas in the clear-cut areas all the wood that is produced is going into saplings and small poles. Many of the suppressed trees will drop out as competition increases and the wood produced will be lost unless a market can be found for small-sized cordwood. At best its value will be low. The odds, therefore, are still greatly in favor of light cutting for forest management purposes.

Northeastern

Remeasurement of Improvement Cutting Plots. On the Bartlett Experimental Forest the first five-year remeasurements on the improvement cutting experiments in all-aged northern hardwood stands were obtained following the 1938 growing season. A preliminary analysis of the data indicated that following removal of approximately 30 percent of the volume, mortality, as compared with undisturbed stands, was reduced in all species except yellow birch. The excessive birch losses may be attributed largely to the opening up of the stand and the resulting change in growing conditions following cutting. Beech and sugar maple in the younger age classes responded very favorably to the treatment. With an increase in age and size, the response was progressively less pronounced, trees over 16 inches d.b.h. as yet showing little or no acceleration over the relatively slow growth rate prior to cutting. The residual volume as evidenced by the variation in plot sub-divisions was a negligible factor, far outweighed by the size and age class distribution.

Silvicultural Control of Gypsy Moth. Timber stand improvement was commenced on a new tract on the Massabesic Experimental Forest in Maine, which was suitable for experimental work on silvicultural control of the gypsy moth. This area is a fifty-year old mixed stand of red oak, white oak, and white pine. Although a reduction in crown volume of the favored food species to about fifty percent of the total is desirable, such a reduction was not feasible on this area because of the preponderance of the oaks. An estimated reduction in crown volume of about thirty percent was obtained on twenty-two acres, leaving fifteen acres as a check. Arrangements are being made with the Bureau of Entomology and Plant Quarantine for cooperative studies on the comparative degree of infestation on the treated and control areas.

Release of White Pine. An inspection of the first timber stand improvement area, cut in 1936-38, revealed that white pine reproduction which has been under suppression for too great a period will not recover when fully released because of apparent sun scald. Plans are being initiated for further studies in this phase of pine management. As a start, the overtapped white pine reproduction on the cruise plots is now tallied according to thriftiness. A thrifty, overtapped tree is tallied as being "oppressed," while a mediocre individual which has been overtapped for some years is recorded as being "suppressed."

Hurricane Damage. Probably little, if anything, of experimental value can be salvaged from the hurricane damage to the set of spruce thinning plots on the Gale River Forest. The set of girdling plots has salvage value as is the case with the aspen release project. The spruce drainage project is practically in-

tact, only minor wind losses occurring in the black spruce swamp.

Losses in the hardwood types on the Forest are fairly extensive. In addition to scattered windthrew, patches of considerable extent have been swept clean of standing timber. Damage to white birch stands on the lower slopes of Mt. Cleveland is extensive. Much of the valuable white ash, cherry, basswood, sugar maple, and yellow birch on the lower loop road has been uprooted.

The heavy losses are in part due to the wind direction with respect to the terrain of the Gale River Forest. With the high point of the forest occurring in the northwest corner, the bulk of tract slopes to the east and south to Gale River which forms its southern boundary. Thus, the wind coming from the southeast met with little resistance until it hit the slowly rising slopes and ridges which reach down from Mt. Cleveland and form the bulk of the Forest. Thus many factors combined to favor maximum damage.

Soil Fauna. The work on spruce litter reduction was finished and a report thereon prepared for publication--except the illustrations.

In order to determine to what extent the all too common decayed wood found in raw humus samples affected the fauna of those samples, two lots of decayed wood were obtained: one (37FLW) from the heart of an old decayed spruce log--quite soft and punky, lying on the surface of the forest floor; another (37FLW) that was completely covered over by the raw humus. Enough of each sample was gathered to fill a one-gallon container.

Certain species found in the litter layer were found in the exposed wood, while certain species found in the lower layers of the raw humus were found in the subsurface wood. However, about twelve species of saprophages were found to be characteristic of the oversurface wood while only three were characteristic of subsurface wood. This analysis helps to account for the presence in quite small numbers of some of the species of the organic layers.

Collembola seem much less specialized in nice preference than the Oribatid mites.

Beetle larvae (chiefly predaceous) were more common in the subsurface wood, while fly larvae (chiefly saprophagous) were common in exposed wood.

Predaceous species of whatever group were more wide ranging (on the whole) than saprophagous species.

The number of samples (one only in each case) precludes positive statements, but from this paucity of evidence it is apparent

that each niche has its peculiar species and that they occur outside of their niche in quite small numbers. Wides, of course, occur throughout all niches in goodly numbers. Restricted species, occurring in goodly numbers are the species of greatest significance.

Northern Rocky Mountain

Harvest Cuttings: Mortality Study in Western White Pine Cutover Stands. Initiated and completed during the 1938 field season was a study of mortality on cutover areas in the western white pine type. The study was made to supplement previously gathered cutover-area growth data by giving further information on mortality, which seems to be the most important and least predictable variable affecting net growth on cutover lands in the type.

Under the immediate field supervision of Brown, a total of 106 samples were taken. Each sample consisted of 30 fifth-acre sample plots taken at 2-chain intervals on random cruise lines in cutover areas. Insofar as practicable, each sample was taken within a reasonably homogeneous area. Several samples were often taken in one large cutting area to sample various parts of it. The samples represent average cutover conditions, neither the best nor the worst. On each plot all live trees were tallied by species, diameter, number of logs, and whether cull trees or merchantable trees. All trees judged to have died since logging were recorded by species, diameter, log length, and estimated cause of death by decades since logging. After a little experience and dating from definitely known deaths, it is believed that death could be determined by decades quite accurately. Cause of death was much more difficult to determine, usually because of secondary symptoms, such as insect attacks, that may develop after the primary cause of death. The procedure was followed of classifying as "unknown" most doubtful cases. While this practice resulted in placing a sizeable proportion of the dead trees observed into this category, it also prevented ascribing a large number of deaths to possibly the wrong cause.

While much of the compilation work yet remains to be done, a few gross figures are now available. The following tables gives the relative importance of the different causes of mortality recognized on all 106 samples combined.

Mortality since logging by tree species and cause expressed as percent of total volume mortality observed

Species	Wind	Insects	Logging fires	Mechanical logging damage	Unknown
Western white pine	19	61	6	4	10
Western larch	17	21	15	8	39
Douglas fir	24	16	23	4	33
Lowland white fir	20	13	14	5	48
Western hemlock	35	1	26	11	27
Western red cedar	21	0	44	19	16
All species	22	24	16	6	32

The high insect-caused loss in white pine and the very low loss by this cause in hemlock and cedar are characteristic of these species. The indicated losses by this agency must be regarded with caution, however, as in many instances beetle attacks may be secondary to some less but apparently primary cause. Wind damage seems to be fairly constant in relative importance for all species and is probably fairly accurate since this cause is easy to determine on the ground. The unknown loss in Douglas fir is believed to be largely due to disease, probably in large part Armillaria mellea. The high unknown loss in white fir is probably mostly due to sudden exposure following logging. Death by disease or exposure is very difficult to determine by superficial examination.

Study of Regional Stand Improvement Practices Initiated. Financed out of CCC funds, the Division of Silvics is undertaking this fall the job of gathering together in systematic and usable form information on stand improvement work done, mostly in the last three or four years, by Region One. Information now available on the National Forests is principally on acreage covered and man-day costs. In many cases, little silvicultural datum is to be had that gives a clear picture of just what was done in the stand. Since the real measure of the efficacy of stand improvement is the actual improvement made in the stand, it is impossible to fairly judge results without good stand data. This information will be especially valuable ten years or so from now when sufficient time will have elapsed for the treated stands to become adjusted to changed conditions and to make appreciable increment. The job the Station is doing is assembling available data from the forests and by field work plugging gaps in silvicultural information.

Pacific Northwest

Ponderosa Pine Silviculture. A strip inventory has been made

of the 42,000 acres recently logged by the Hines Lumber Company, Malheur National Forest, under the new maturity selection system of marking. This will be, in the decades to come, a valuable source of positive information on the growth and mortality that follow this method of cutting.

Cone crop reports compiled by this office show that nearly all species are producing mediumly well this year, an unusual condition. Accordingly small amounts of seed of a number of species are being collected for experimental use and exchange with our correspondents.

Douglas Fir Silviculture. Activity during the summer months has centered around the silvicultural phases of "selective logging" in the Douglas fir type. Isaac and Munger visited several of the areas, on both national forest and private land, that are being "selectively logged" and upon which sample plots were established before operations started. In cooperation with the Regional Forester's office and the West Fork Logging Company a recruise has just been completed of a large area so logged by the company at Mineral, Washington. When worked up the data will show amount utilized, amount destroyed, and the composition and condition of the reserve stand. The unique feature of this operation is that part of the area was logged by tractors and part by the standard steam donkey-high lead method for the purpose of comparing the results of the two methods on the reserve stand.

Seedling checks were made on studies under way in cooperation with the Biological Survey on seed consumption by rodents. Early results indicate that Port Orford cedar seed is taken less by rodents than other Northwest species.

Thinning Studies. In response to the growing interest in stand improvement activities, the Station is devoting an increasing amount of attention to this field. About the first of September two Junior Foresters were assigned by the Regional Forester to the Station to assist in giving technical guidance to the CCC program of stand improvement. They are commencing with the examination of areas which have already been spot thinned by CCC crews in the ponderosa pine region.

Currently steps are being taken to establish on both the Wind River and the Pringle Falls Experimental Forests large scale experimental thinning projects in which merchantable material would be removed through commercial timber sale channels. Six extensive methods of thinning plots, averaging 25 acres each, were laid out in the 97-year-old Douglas fir stand on the proposed Panther Creek piling sale near Wind River, and marking of timber was started. As a result of this preliminary work it is believed that desirable improvement cuttings can be made in this stand on a com-

mercial basis now that CCC roads have made the area accessible.

Sample stand table data collected from the even-aged immature ponderosa pine forests near Lookout Mountain indicate the need for thinning in these stands, and also show the opportunity for removing stems of merchantable size while leaving a desirable growing stock for increased increment.

Plans have been prepared covering both intensive and extensive phases of a study of natural pruning in second-growth stands of Douglas fir. Four trees from the Panther Creek stand which have been cut into sections and will be further dissected, will provide for the intensive study of knot formation and occlusion.

Rocky Mountain

Harvest Cuttings: Lodgepole Pine. An inventory of the one hundred acres of plots on the Fraser Experimental Forest designed to test methods of harvesting lodgepole pine will be completed in October. With complete information on diameter, volume, visible defect, and tree class, plans will be made for marking and selling the timber. With isolation strips and areas between plots there should be close to 200 acres of lodgepole pine to sell. The total volume in trees 10 inches d.b.h. and larger should run close to three million feet, board measure.

Mortality of Cut-over Lodgepole Pine. Six strips, each a mile long and one chain wide have been established on five national forests in Region 2. These strips are on land just cut-over and are designed to record actual mortality in the reserve stand year by year. Recorded by 2-chain lengths various reserve volumes may be compared as to growth, mortality, and change in tree classes.

Tree Classification. In 1936 Keen's tree classification for ponderosa pine was modified to reflect growth potentialities of stands in the Black Hills. In June, Hornibrook repeated the process with success, on the Montezuma National Forest.

The application of lodgepole pine tree classification to marking has been discussed and tested repeatedly in the field by Taylor and Regional Officers and other administrative men. Revision of the classification involving the breaking down of the C class into two parts will be one result of these tests.

Stand Improvement: Methods of Thinning. In 1933 when CCC enrollees thinned many thousands of acres in lodgepole pine in Colorado and Wyoming and ponderosa pine in the Black Hills, several administrative thinning study plots were established. Re-

measurement of four sets of lodgepole plots has been made during the current season. The results, although not secured by the most modern statistical technic will show whether or not CCC thinning is increasing the growth of young stands and approximately how much.

Southern

Stand Improvement in the Loblolly Pine-Hardwood Type. The recent remeasurement of two 2-acre permanent sample plots established 5 years ago at Urania, La., shows a very striking increase in the growth of loblolly pine as a result of cutting and girdling large hardwoods. When the plots were established, the stand of loblolly and shortleaf pines and mixed hardwoods was irregular or patchy, and very definitely understocked on the whole, although overstocked in small groups. The original timber had been cut about 30 years previously and the stand was composed principally of second-growth pines (mostly loblolly) about 25 to 30 years old, intermixed with large hold-over pines and hardwoods. The stand needed, and was given on one plot, a general improvement cutting that removed pine and hardwood sawlogs and pine pulpwood, and girdled all hardwoods in and above the 10-inch d.b.h. class that were not suitable (either then or potentially) for sawlogs. Thirty-eight large hardwoods were girdled on the improved plot, and two hardwoods were cut into sawlogs. All of the girdled trees were dead 38 months after girdling. On the check plot, 39 hardwoods of similar size were left untouched. In addition to obtaining the usual records needed to show the effects of the improvement cutting on an area basis, a special study was made of the growth and mortality of all pines within 15 feet of the bole of each of the large hardwoods (more than 9.5 inches d.b.h.) on the two plots. A summary of pertinent data for these pines, which were all loblolly, is given in the following table:

Stand, volume, and growth data for loblolly pines within
 15 feet of hardwoods more than 9.5 inches d.b.h.
 Actual values for 2-acre plots

1/ 1933				1933 to 1938				1938			
d.	No. of Basal	Vol-	No. of Ave.	Increase	d.	No.	Bas-	Vol-			
b.	trees	area	ume	trees d.b.h.	b.	of	al	ume			
h.	Sq.ft.			that growth	h.	tre					
In.				died of over	In-	ches					
				tre	ches						
				check							
				that plot							
				lived	Act.	%					
				Inches	In.						

IMPROVED PLOT

1	34	.250	-	7	.322	.255	381	1	14	.115	-
2	76	1.777	-	14	.358	.288	412	2	56	1.369	-
3	88	4.455	-	5	.529	.411	348	3	56	2.801	-
4	50	4.186	-	1	.663	.442	200	4	61	5.318	-
5	18	2.372	.28	1	1.118	.754	207	5	36	4.635	.52
6	9	1.723	.27	-	1.178	.747	173	6	12	2.319	.39
7	8	2.122	.43	-	1.362	1.076	377	7	11	2.906	.57
8	14	5.023	1.10	-	1.457	.824	130	8	6	2.063	.46
9	3	1.348	.30	-	1.467	.467	47	9	10	4.542	1.08
								10	8	4.224	1.00
								11	2	1.332	.31
Tot. 300 23.256 2.38 28									272	31.624	4.33

CHECK PLOT

1	16	.135	-	13	.067			1	2	.019	-
2	67	1.558	-	34	.070			2	29	.637	-
3	94	4.710	-	32	.118			3	53	2.631	-
4	51	4.449	-	3	.221			4	55	4.840	-
5	34	4.554	.54	1	.364			5	28	3.695	.48
6	13	2.535	.42	-	.431			6	21	4.169	.76
7	7	1.814	.36	-	.286			7	11	2.984	.60
8	3	1.075	.24	-	.633			8	1	.376	.08
9	3	1.308	.29	-	1.000			9	3	1.337	.30
								10	1	.535	.11
								11	1	.624	.13
Tot. 288 22.138 1.85 83									205	21.847	2.46

1/ For the improved plot, the values given represent the stand after the cutting.

From the table it has been calculated that the basal area increased 36.0 percent on the improved plot but decreased 1.3 percent on the check plot. Considering only the pines of pulpwood size (5-inch class and larger), the basal area increased 75.4 percent on the improved plot, and only 21.6 percent on the check plot. Mortality during the 5-year period amounted to 9.3 percent of all the pines and 1.9 percent of the pulpwood-sized pines on the improved plot, compared to 28.8 percent of all the pines and 1.7 percent of the pulpwood-sized pines on the check plot. Thus there was essentially no difference in the mortality of pulpwood-sized pines on the two plots, but a very striking difference in the growth rate of this class of trees.

In actual pulpwood volume, the improved plot increased 82.0 percent and the check plot only 33.0 percent. After adjusting for the slightly different pulpwood volumes in 1933, the improved plot produced 1.04 more cords of pulpwood during the 5-year period. This increased volume, applicable only to the area within 15 feet of large hardwoods, accounts for the major effects of cutting and girdling large hardwoods as distinguished from other phases of stand improvement. The girdling actually required only 2 man-hours, although this requirement might be conservatively increased to 15 percent (2.3 man-hours) to allow for somewhat more careful and thorough work, and to allow for the two trees actually cut into sawlogs rather than girdled. The effect of girdling for the first 5 years, therefore, has been to bring about an increased growth of about one-half cord per man-hour of girdling. At current prices and costs, this represents approximately an even break in the first 5 years. The present growth differences will of course greatly increase as time goes on, and the net value of the girdling will rise sharply. The results of this study to date have been summarized in a short article submitted to the Journal of Forestry.

Loblolly Tree Study for Growth and Mortality. A total of 271 loblolly pines left on the methods-of-cutting plots recently established on the San Jacinto Experimental Forest were tagged, measured, and described in detail in May and June. The trees selected for this study were distributed over 5 different plots, representing selective cuttings at 10- and 15-year intervals, shelterwood cutting, and cutting according to the minimum-requirements set up by the southern pulpwood industry. The object of the study is to determine the growth and mortality of trees in partially cut stands, as related to the size, character, and position of the trees. The fine opportunity provided by the new methods-of-cutting plots to start with trees covering a wide range of size, character, and position, and occurring in stands just cut over, made it desirable to begin this tree study at once. Further new work in this field, however, will be undertaken only after the completion of intensive analyses of available data and the formu-

lation of more comprehensive plans.

Olustee Management Plan. A comprehensive experiment in forest management is being installed on the Olustee Experimental Forest in northern Florida to compare the relative merits of different methods of handling stands of longleaf and slash pine in the flatwoods of the Southeast and to demonstrate sound forest management. Nine fundamentally different methods of management will be tested:

1. Even-aged forest, managed primarily for small-dimension wood products.
2. Even-aged forest, managed primarily for gum products.
3. Even-aged forest, managed primarily for large-dimension wood products.
4. Selectively cut forest, managed primarily for small-dimension wood products.
5. Selectively cut forest, managed primarily for gum products.
6. Selectively cut forest, managed primarily for large-dimension wood products.
7. Farm woodlot management, involving selective cutting with an annual cut of variable volume.
8. Even-aged forest, stressing use of fire in silviculture and protection.
9. Selectively cut forest, on cypress and hardwood areas unsuited to pine.

By varying (1) cutting cycles, (2) the interval from the present to the time of major harvests, and (3) differentiating between round and worked timber, these nine methods have been expanded to 64 separate treatments. Further treatments will be added when method No. 8 has been expanded by varying burning schedules. Method No. 9 may also be expanded by varying the handling of stands in the ponds and swamps.

The total area involved is approximately 2,800 acres. The unit of area (compartment) for each treatment is 10 acres. In designing the experiment, provision has been made for each treatment to be tested on at least two such compartments.

Provision for integrated utilization of merchantable products is made throughout all treatments, although in the treatments under the first six methods listed above some one class of product will take precedence over the others. The measure of relative merit for a particular treatment or method in comparison with others will be the net annual return per acre in dollars; no other measure is common to all treatments.

Removal of the various products will be effected by the usual Forest Service sales and leases. Insofar as it is practicable to do so, local residents will be favored through emphasis on

many small sales rather than few large sales. In this way the social values inherent in good forest management will be realized.

The marking for the first 57 treatments (first 6 methods) is now essentially complete and the first sale will be made in October or November. It is estimated that there will be approximately 200 cords of pulpwood, 3 crops (30,000 faces) of naval stores, and 10 M b. f. of sawlogs offered for sale this fall.

Longleaf Pine Competition Study. A two-year study of the effect of vegetative cover on the growth of longleaf pine seedlings has been completed, and a report is being prepared. The study involved the comparison of longleaf pine seedlings growing alone in bare soil, growing alone in mulched soil, and growing in close proximity to grasses. These three cultures were divided into two series, one of which received a weekly allowance of 500 mililiters of water, whereas the other received only half that amount. The cultures including grasses were treated in three different ways: grass burned annually, grass clipped semi-annually, and grass undisturbed ("rough"). Analysis of the data showed that the best growth of the pine seedlings took place in the cultures in which the grass was burned and in the cultures from which the grass was excluded. The poorest growth occurred in the "rough" cultures. In the cultures where the grass was clipped the growth was intermediate. Soil moisture also affected the growth of the pines, since the cultures receiving the greater amount of water showed the greater growth.

Ecology of Savannas. A brief exploratory study of a typical savanna (low, boggy, treeless area) on the Harrison Experimental Forest revealed some interesting facts which seem to account for the absence of pines on such areas. The study was undertaken as a result of discussions with the District Ranger of the DeSoto National Forest concerning the possibilities of reforesting savanna lands. Several quadrats were laid out in the zone of longleaf pine reproduction outside the savanna, in the middle of the savanna where pines were absent, and in the intermediate or transition zone. In these quadrats soil samples were taken for mechanical analysis, and for the determination of colloidal content, moisture content, fertility (N, K, and P content), pH, and the rate of percolation of a column of water. The vegetation was tallied on each quadrat to determine the predominant species in each of the three zones. The following table presents some of the most significant data.

Zone	Predominant species	Rate of percolation of a column of water	Moisture content	pH
Abundant pine reproduction outside savanna	<u>Andropogon scoparius</u> <u>Pityopsis graminifolia</u> <u>Helianthus radula</u> <u>Pinus palustris</u>	14 Minutes	12.8	5.0
Scanty pine reproduction along edge of savanna (transition)	<u>Campuloculus aromaticus</u> <u>Eriocaulon decangulare</u> <u>Pilotaxis ramosa</u> <u>Eryngium virginianum</u>	24	27.7	4.8
No pine reproduction, in middle of savanna	<u>Drosera tracyi</u> <u>Lycopodium alopecuroides</u> <u>Sarracenia sledgei</u> <u>Sarracenia purpurea</u> <u>Rhexia alifanus</u> <u>Rhexia lanceolata</u> <u>Xyris iridifolia</u>	80	54.7	4.6

The high water-holding capacity of the soil and the low relative elevation of the area are considered to be primarily responsible for the absence of pines in the savanna, despite the abundance of seed in the vicinity. The results of this study were incorporated in an office report for limited distribution in the region in which savannas are common.

MENSURATION

Appalachian

Converting Factors for Oak Cordwood. A study of the relationship (1) between stacked units (160 cubic feet) and solid cubic feet of peeled and unpeeled mixed oak topwood and bolewood, and (2) between stacked units and board feet of mixed oak logs was undertaken in 1937 and was completed during the summer. The need for these converting factors is urgent now that hardwood is being used more widely for pulpwood. The findings have been partially reported before, and results of the completed study are summarized below:

1. The solid cubic foot content in a stacked unit of oak topwood is dependent upon the number of sticks per stacked unit and the percent of round sticks. For the data used in this study the formula for peeled wood is:

$$\begin{aligned} \text{Solid cu. ft. per } 8 \times 4 \times 5\text{-foot stacked unit} \\ = 0.2274 \text{ (number sticks per stacked unit)} \\ + 0.4275 \text{ (percent of sticks round)} + \\ 69.9582. \end{aligned}$$

Although contrary to well-founded opinion, the increase in solid cubic foot content per stacked unit with increase in number of sticks per stacked unit is a significant relationship and is probably due to the fact that large pieces are not split by wood cutters because of excessive knots and crook. Stacked units composed of relatively small number of sticks are therefore associated with extreme crook or knottiness.

2. The bark on oak topwood amounts to approximately 14 percent of the total solid cubic volume of unpeeled wood, approximately 13 percent of the total stacked volume of unpeeled wood.
3. The solid cubic foot content in stacked units of split oak bole wood (i.e., cordwood made from sawlog material) is independent of the number of sticks per unit. For the data used in this study the solid contents per 160-cubic-foot cord of peeled oak bole wood is 108.8 cubic feet.
4. The bark on oak bolewood amounts to approximately 13 percent of the total solid cubic volume of unpeeled wood, approximately 11 percent of the total stacked volume of unpeeled wood.

5. Although in the past a single average figure has been used to convert board foot volume to stacked units, or vice versa, the study showed that for logs of a given length the converting factors vary widely with log diameter. The extent of this variation is indicated by the following table.

Converting Factors - Woods Run of Lengths
160 Cubic Foot Units of Peeled Wood

Log d.i.b.	Scribner Dec. C.		Internat. 1/4 Rule		Doyle	
	Bd. ft. per unit	Units per M bd. ft.	Bd. ft. per unit	Units per M bd. ft.	Bd. ft. per unit	Units per M bd. ft.
10	473	2.114	585	1.709	329	3.040
14	564	1.773	665	1.504	493	2.028
18	664	1.506	717	1.395	608	1.645
22	712	1.404	751	1.332	688	1.453
26	771	1.297	774	1.292	749	1.335
30	771	1.297	789	1.267	794	1.259

Approach Toward Normality of Understocked Stands. As mentioned in the monthly report for April 1938 (p. 9) a method has been devised for determining the rate of approach toward normality of understocked stands of loblolly pine. Publication of the results was withheld pending further investigations into the applicability of the method to stands of Virginia pine. It was found that similar procedures can be used for both loblolly and Virginia pine stands. The main advantage of the method is that the change in density with age is estimated from observed average differences in densities of present stands of different ages. In addition to the determination of actual rates of approach to normality, a procedure was developed for applying these findings in making growth estimates from normal yield tables. A manuscript on the subject has been submitted for publication in the Journal of Forestry.

Growth Estimates Based on Increment Borings. A study recently completed investigated the sources and magnitude of errors inherent in making growth estimates by projecting present stand tables on the basis of increment borings. Actual data from the Forest Survey, a national forest working circle, and a Station project, were used. It was found that failure to account for increment of bark tends to underestimate volume growth by approximately 10 percent. Another factor frequently overlooked is that diameter increment during a given period is a function of the diameter of the tree at the beginning rather than at the end of the period. To consider the diameter increment as a function of present tree diameter may result in errors in the growth estimate ranging from

-13 percent to +5 percent. Whether this source of error results in an under- or over-estimate of growth and thus adds to or partially compensates for errors resulting from failure to account for bark increment depends in large part upon the shape, direction, and steepness of the relationship curves between d.b.h. growth and d.b.h.

California

Growth in Selection Stands. Computation for growth and loss predictions in mixed selection stands was brought almost to completion by September 30. The material being prepared for publication was reviewed at a conference on marking policy, September 23, with E. E. Carter, Division of Timber Management, Regional Forester Show, Assistant Regional Forester Woodbury, and C. E. Dunston, J. R. Berry and P. R. Kevin of the Section of Timber Management in Region 5.

Lake States

Taper Table. A taper table has been prepared for jack pine based on the measurements of 655 trees obtained throughout the Lake States.

The table indicates the diameter inside bark at regular intervals above the ground. By means of this table it is possible to determine how many logs or bolts of different diameters can be cut under any utilization practice from trees of various sizes and to scale the different parts of the tree in different units of volume.

Rocky Mountain

Lodgepole Pine Growth and Yield. This season's work on growth and yield of selectively cut lodgepole pine resulted in securing 40 more plots, bringing the total to 85, and in covering most of the range of merchantable lodgepole pine in Colorado and Wyoming. Next season a few additional plots will be obtained to fill gaps in the basic data. Final computation of yield tables will await Hornibrook's return from graduate study in the spring of 1939.

Growth of Ponderosa Pine in the Black Forest. A short co-operative study with the Soil Conservation Service was made in May to determine average growth rates for stands of young ponderosa pine being cut-over more or less continuously by private owners in the so-called Black Forest, an area lying east of the Pike

National Forest. A report on this study has been prepared.

Southern

Nursery Inventory Technique. In two previous monthly reports (December 1937 and February 1938) there has been some discussion of the accuracy of sampling in making estimates of average density (total number of seedlings per unit area) for a forest nursery inventory. Since then the following procedure for making a forest nursery inventory has been developed:

1. Obtain from one set of samples an estimate of the average density. Take at least 1 sample in each bed.
2. From another set of samples obtain the relationship of percentage of plantable seedlings (percent plantable) to density.
3. Using the average density obtained in (1), estimate the percent plantable from the relationship found in (2).
4. The total number of plantable seedlings is then the product of (a) average density, (b) estimated percentage of plantable seedlings divided by 100, and (c) total number of sampling units.

A partial check of this procedure was made at the Stuart Nursery. This check was based on a randomly selected 2 percent estimate of density, and a 1 percent estimate of the relation of percent plantable to density. The data used for the latter estimate were collected at the time the seedlings were lifted and therefore do not include the error of estimating the change in the grade of seedlings during the interval between inventory and lifting. The result of the check was an estimate of 180,948 plantable seedlings on 54 beds, as compared to 181,825 plantable seedlings actually lifted.

Several interesting problems were encountered in this work. If the error of the estimated number of plantable seedlings is desired, the usual formula for the error of a product cannot be used because the estimated average density is not independent of the estimated percentage of plantable seedlings. The equation expressing the error can, however, be found by using the technique discussed by W. E. Deming in section 8, page 27, of "Some Notes on Least Squares," (mimeographed by U.S.D.A. Graduate School, 1938).

In setting up the recommended sampling procedure, use was made of the method cited on page 177 of Tippett's "The Method of Statistics" (first edition, 1931). The type of problem that this method helps to solve may be stated thus: "Given a certain sum of money for completing a sampling job in a stratified population, how

many samples should be taken in each stratum of the population?" Tippett's method was modified for the nursery inventory study as follows: Let the total amount to be invested be T , let C_B be the cost of locating a suitable stratum (seedbed), and let C_W be the cost of obtaining a sample in this stratum. Then

$$T = N_B C_B + N_B N_W C_W \quad (1)$$

where

N_B = the number of strata being sampled, and

N_W = the number of samples per stratum

The standard error of the mean of a stratified population is

$$\sigma_M^2 = \frac{\sigma_B^2}{N_B} + \frac{\sigma_W^2}{N_B N_W} \quad (2)$$

where

σ_B^2 = the variance between strata, and

σ_W^2 = the variance within strata.

The problem then is to find the values of N_B and N_W for which σ_M^2 is a minimum. To do this the methods of calculus are used. The first derivative of σ_M^2 is equated to zero and solved for N_B or N_W , whichever one has not been eliminated by using equation (1). The solution takes the form

$$N_W^2 = \frac{C_B}{C_W} \cdot \frac{\sigma_W^2}{\sigma_B^2}$$

REGENERATION

Appalachian

Reexamination of T.V.A. Plantings. The reexamination of the experimental planting plots established in cooperation with the Tennessee Valley Authority was begun on September 20. Early reports indicate high first-year survivals and exceptional growth in some cases. Germination counts, made in late May and early June, on black walnut and four species of oak established by direct seeding showed only a very few plots damaged by rodents. In some cases, however, rodents have continued their depredation by cutting off the stem and eating the tap roots even after seedlings were well above the ground.

Study of First-Year Mortality in Plantations. A study designed to relate first-year mortality to site, meteorological conditions, and vegetative competition has been in progress throughout the summer. It involves 6 species, 2 soil types, and 2 aspects. Examination and measurement of staked and numbered trees has been made each ten days. A rather complete record of meteorological factors has been taken throughout the summer. Soil temperatures and soil moistures have been recorded. Vegetative competition has been tallied for each seedling at each ten-day examination period. The exceptionally good growing season resulting in high survival of all species has probably reduced the value of the work for this season.

Regeneration of Cut and Burned Spruce Lands. This summer for the first time the Station has had the opportunity to start serious work on the problem of regeneration of the cut-over and burned-over spruce type lands at high elevations in the Appalachians. A party of three spent about six weeks in the region working on a problem analysis. The work included a survey of existing plantations and a classification of vegetative and soil types on the problem areas of the spruce type. The report on this work will serve as a basis for the establishment of actual experiments designed to show the way toward reforestation of these "sore spots".

Seed Spot Studies. All major preparations for both fall and spring sowing were completed during the summer. This project contemplates testing the possibilities of establishing the three common species of pine by means of seed spotting on both good and poor-site Piedmont old fields. Locations representative of northern Piedmont conditions were found on the proposed Lee Experimental Forest in Buckingham County, Virginia, and those representative of southerly conditions have been located on the Enoree district of the South Carolina National Forest.

In addition to testing the effect of site on the survival and growth of the three species in each of these localities the experiment will determine the influence of several methods of seed spot preparation.

California

Brush-field planting. Attention was concentrated on three planting experiments in northern California brush fields designed to compare three brush treatments - burning, stripping, burning and stripping; Jeffrey pine and ponderosa pine; nursery stock and seed spots; plants sprayed with rabbit poison and unsprayed; three grades of stock; and stock from the Durbin and Feather River nurseries. Progress reports on these rather complex tests will be completed during the winter. Preliminary summaries show that survival

in 1938 will be only 25 to 50 percent for transplants as compared with 90 percent in 1937. Survival for seed spots appears somewhat better than for transplants. No striking differences assignable to brush treatments have appeared. Jeffrey pine is definitely superior to ponderosa in the Burney Spring (Lassen) area, but ponderosa surpassed Jeffrey pine in the Bottle Spring (Plumas) plantation. Spray was not effective in increasing survival in 1937. Somewhat larger differences between sprayed and unsprayed stock appear this season, but these probably are not consistent enough to be significant. Large ponderosa transplants from the Durbin nursery were superior to stock of other grades, species and sources. Rodents damaged 58 percent of the transplants at Bottle Spring.

Landscape Nursery. There were 37,076 plants in stock at the Gill Nursery for the month ending September 30, 1938. These are for the most part potted plants and include:

23,000 ornamental landscape plants
9,000 plants for erosion control and roadside
planting
5,000 deciduous trees for flood-control use

Principal additions to the nursery material during the past three months were 400 plants of Adenostoma sparsifolium for erosion control trials, and a quantity of cuttings of Baccharis emoryi from which it is planned to raise stock for a trial of this species on sites and under conditions similar to those for which Baccharis viminea has been so successfully employed during the past several years.

During September nine species were added to our stock of native plants that heretofore had not been propagated. Our collection of native plants is now probably the largest in any nursery in the State. A total of 6,479 plants was potted during the four summer months, June to September.

During the summer months, germination tests were run on seeds of over 40 native Californian plants of which little has been known concerning the germination requirements. Results of these tests, carded and filed, have been added to our already large fund of knowledge concerning California native plant seeds.

Continued research has been given to germination methods for different species of Eriodictyon. This is a genus of rankly growing xerophytic shrubs, represented by three species and several varieties (according to Jepson) in California, which have so much apparent promise for road-fill stabilization use that it is desired to test their efficiency for this purpose. A planting project has been dependent, however, on solving the problem of

germination, which in the past had been considered hopeless with this genus.

The success, reported in June, in germinating the central and northern California species, E. californicum, by stratification at 0° C for long periods (exceeding 3 months) led to the trial of this method on the southern California species E. trichocalyx. This has now been successful. Seeds of the remaining California species and varieties are now undergoing treatment.

Central States

Planting. Most of the months of July and August have been spent in developing work plans for the 1939 planting season, in analyzing and compiling data from nursery and plantation plots, and on a manuscript, "Behavior of one-year pine seedlings under typical old-field ground covers."

Nursery Experiments. Three sets of nursery soil tests were established in the late spring to test the effects of different fertilizer combinations. One series of experiments is located at each of three nurseries: Chillicothe, Ohio, Veville, Indiana, and Licking, Missouri. Various kinds of phosphate fertilizers, acid phosphate, rock phosphate, iron phosphate, and aluminum phosphate are being tested at pH5 and pH7 with and without peat. Different kinds of nitrogenous and potassic amendments have been used: soybean meal, ammonium sulfate, blood meal, potassium sulfate, tobacco stems, and permutite.

A greenhouse experiment was started early in the spring to test the effect on pine seedlings of changing the carbon-nitrogen ratio in soil from the Chillicothe nursery by the use of different amounts of ground cellulose, blood meal, and soybean meal.

Measurement of the 1938 seasons growth in field planting was started in September. Also areas for experimental planting next spring were selected.

Site and Soil Studies. Reforestation of vast areas of abandoned land in the Central States will be slow because of the magnitude of the problem. It probably will not be feasible to plant all such areas, nor will it be universally necessary if fire and grazing are controlled. Much can be done in the way of soil and site building by recognizing and using natural succession of vegetative covers.

Vegetative covers of all kinds reduce erosion and add organic matter to the soil; some are superior to others. In certain parts of the Central States sassafras is the first tree cover

to become established after abandonment. In fact, sassafras regenerates so rapidly and so thickly in some old fields that the crowns close at ages from 5 to 10 years. The farmer has only to relax his efforts for a very few years and he has a young sassafras forest in place of a cornfield.

Sassafras is able to occupy very poor soil areas. It serves as a nurse crop for other hardwood species, and, being intolerant, drops out of the forest community very quickly after becoming overtapped. Sassafras seems to produce a great deal of litter and should be a valuable species on certain soil areas, particularly heavy clays and silty clays where pines will not thrive.

Nursery Studies. Statistical analysis of data on differences in height growth of pitch pine seedlings fertilized and unfertilized in the Chillicothe, Ohio, nursery disclosed some significant results. Phosphates in general increased height growth.

Aluminum phosphate applied at the rate of 400 pounds phosphorus per acre, superphosphate at the rate of 100 pounds phosphorus per acre and liquid phosphoric acid at the rate of 100 pounds phosphorus per acre gave highly significant height increases over check plots. Rock phosphate at the rate of 400 pounds phosphorus per acre gave non-significant results probably because the soil reaction was near the neutral point. Acidifying the soil no doubt would have rendered the rock phosphate more available. Theoretically there is some merit in rock phosphate applied in large amounts to an acid soil, especially a light nursery soil which has a low absorptive capacity for soluble phosphates. The response to aluminum phosphate was pronounced probably because of the soil's high pH.

Native pine duff applied at the rate of 8000 pounds per acre gave non-significant results.

Neither nitrogenous nor potassic fertilizers produced any significant increase in height growth.

Data on survival disclosed highly significant depression by lime, and by blood meal and ammonium sulfate (100 lbs. nitrogen per acre). Raising the pH of the soil caused high mortality as did also large amounts of soluble nitrogen. Soybean meal (500 lbs. nitrogen per acre) did not affect mortality but in another nursery larger amounts resulted in almost complete mortality. Ammonium sulfate (100 lbs. nitrogen per acre) produced a significant increase in mortality. Sodium nitrate (100 lbs. nitrogen per acre) gave non-significant mortality effect. These results with soluble nitrogenous fertilizers agree with our previous results in that injury results in the early stages of pine seedling growth. This

is not caused by "chemical injury" because the amounts applied were not dangerous and were applied in solution dilute enough to allow ample distribution in the soil. Too much nitrogen perhaps creates more favorable conditions for damping-off fungi.

Intermountain

Seed Storage: Ponderosa Pine. In October 1936 a ponderosa pine seed storage test was initiated at the Boise Basin Branch Station, the test involving six types of storage and seven sources of seed. The first germination trials on this series were run during the winter of 1936-37 (four months after collection of seed). Other tests have been run during June 1937 and 1938. The plan calls for year runs over a period of six to eight years, which represents the maximum expected lapse between very good or at least moderately good seed crops for this species.

All sample seed is stored in one-half gallon glass fruit jars "sealed" in the usual manner with rubber rings. The use of small containers and small samples (2-pound lots) is not deemed particularly objectionable since seed moisture problems are not serious in ponderosa pine in this vicinity. Types of storage comprise the following:

- A. Commercial cold storage at 32° F.
- B. " " " at 0° F.
- C. "Above-ground" cellar storage: temperatures fluctuate slowly between range of 32° to 60° F.
- G. Ground storage: 30 inches below the surface; temperatures fluctuate slowly within the range of about 34° in the winter to about 70° in the summer.
- O. Outside storage: jars in partial sunlight; temperatures fluctuating seasonally from -40° in winter to 100°+ in summer, diurnal changes being great and rapid for example, from about 40° in the early morning in midsummer to 100°+ in the afternoon.
- S. Shop attic storage: practically the same as G except exclusion of sunlight.

Germination percentages from the June 1938 tests are given in the table below:

TYPES OF STORAGE

Seed source	A	B	C	G	O	S	Mean
June 29 count							
1	40.4	42.8	39.0	45.8	27.8	27.8	37.3
2	30.4	30.8	32.8	28.2	18.6	21.6	27.1
3	24.8	28.2	26.6	27.6	15.8	22.4	24.2
4	47.0	52.2	48.6	41.8	27.4	35.8	42.1
5	30.0	32.0	33.6	29.0	22.6	26.0	28.9
6	37.0	37.0	39.4	34.0	20.0	27.8	32.5
7	28.2	27.4	24.2	16.4	15.6	12.0	20.6
Mean	34.0	35.8	34.9	31.8	21.1	24.8	30.4
July 14 count							
1	65.8	65.4	67.0	69.2	62.0	61.4	63.1
2	60.0	58.2	60.0	62.8	49.2	57.4	57.9
3	57.4	58.6	56.4	51.8	49.4	49.8	53.6
4	67.6	69.6	71.0	67.2	57.8	62.0	65.9
5	52.2	55.0	54.6	47.8	51.4	49.4	51.7
6	56.6	53.4	60.4	57.0	47.8	46.8	52.7
7	57.4	54.8	58.8	50.6	46.2	43.2	51.8
Mean	59.6	59.3	60.9	57.2	52.0	52.9	57.0
July 29 count							
1	82.0	77.2	82.6	79.6	68.8	74.2	77.4
2	79.0	74.0	77.6	77.4	73.8	73.6	75.9
3	72.8	78.2	76.2	69.8	71.8	70.6	73.2
4	76.0	77.2	78.8	80.4	63.8	76.0	75.4
5	72.4	73.8	72.6	71.6	66.0	71.8	71.4
6	68.6	64.0	70.8	60.2	58.8	57.4	63.3
7	76.2	75.8	83.8	75.2	70.0	71.4	75.4
Mean	75.4	74.3	77.5	73.4	67.6	70.7	73.1

In general, the results indicate the superiority of low and "constant" temperature storage, particularly in regard to retention of germinative energy of seed. At this stage differences between the four low constant types appear to be neither statistically significant nor practically important. The outside and shop attic storage, however, yield significantly lower percentages but the differences in germinative capacity are not so great as might be expected in view of the drastic conditions involved.

Artificial Seeding: Ponderosa Pine. Since 1935 several small scale trials of artificial seeding have been conducted in the Boise Basin. The answers sought from these tests have concerned primarily such questions as what is the best season for sowing and what kinds and what amount of protection are necessary

to save seed and young seedlings from rodent and bird depredations. Many interesting clues have been obtained in regard to response of seedlings under various conditions. Two definite conclusions can already be drawn; namely, that seeding in spots without some mode of protection is doomed to fail except under very special circumstances, and that reduction of competition must be effected in one way or another before reasonably high survival and good growth can be expected.

How much of the competing vegetation must be annihilated to produce significant effects is not known. Complete denudation such as results from a severe surface fire yields desirable results from seedling survival and initial growth standpoint; but there is serious question whether mere scraping and working of a square foot or two of surface soil as results in scalping operations adds anything except to the job load.

A study now being initiated in the Boise Basin is designed to answer some of the questions of reduction in surface competition and to determine conclusively whether artificial seeding is as successful under a wider variety of conditions in central Idaho as the earlier studies have indicated. The study involves three degrees of soil preparation, three aspects, different durations of protection, and randomization of blocks over a period of three years.

Lake States

Planting Seminar. The Lake States and Central States Forest Experiment Stations, together with Region 9, were hosts from September 12 to 17 to members of the Washington Office and representatives from the Appalachian, Southern, Rocky Mountain, and Intermountain Forest Experiment Stations, and Regions 7 and 8. Various plantations and nurseries were visited on a field trip through the Region which concluded with a three-day seminar at the Region 9 Training School at Eagle River, Wisconsin.

On the trip through Lower Michigan the work of the Station at the Chittenden nursery and on the Manistee National Forest was presented by P. O. Rudolf. The two main problems being studied at the nursery are the effects of the density of sowing upon the development of jack pine and red pine stock, and the effects of the degree of watering on the development of jack pine stock.

On the Manistee National Forest the Star Lake Block and the Big Prairie area were visited. The questions being studied on the Star Lake Block, one of a series of four 80-acre blocks, involve species, classes of stock, and methods of planting. A 10-acre plot is planted annually on each block. Weekly records are kept throughout the growing season on soil and air temperature, precipitation,

and soil moisture content.

The Big Prairie area presents a problem in reclothing the sand-blow areas common to the northwestern part of the lower peninsula of Michigan. Experiments are under way to determine if it is possible to reclaim the areas directly with trees or whether it will first be necessary to establish a grass and shrub vegetation.

In Wisconsin Stoeckeler did the honors for the Station. Plantations were visited on the Nicolet National Forest which showed the beneficial effect of shallow water tables on plantings of red and jack pines and the direct seeding of jack pine in furrows (an administrative study).

A plantation established in 1929 and 1930 on private land near the east boundary of the Nicolet National Forest with a row-by-row mixture of red, white, jack, and Scotch pine, and white and Norway spruce demonstrated the value of jack and Scotch pine for the open sand-plain country.

At the Hugo Sauer Nursery the effects of fertility, density of sowing, and root pruning were noted on plots of red, white, and jack pine and white spruce.

Seed Studies. In spite of the delay caused by the Station's change in quarters, considerable progress has been made on the seed manual project. Since little or no information regarding the seed characteristics and germination habits is available for many of the Lake States trees and shrubs, it has been necessary to work this out in the St. Paul laboratory.

Accordingly, Roe with the cooperation of the men at the various Branch Stations has collected 275 seed samples representing about 130 species. In addition, germination tests have been run on about 110 samples.

One rather surprising fact brought out by the summer's work was the discovery that the seed of red maple and slippery elm, contrary to the usual habit of spring-ripening species, showed no germination when sown and put in the germination room without further treatment. The present indications are that the seed of both these species shows considerable response to a period of low temperature stratification. So far the details have not been fully worked out.

Drought Resistance of Nursery Stock. A drought machine large enough to test 280 plants simultaneously was constructed at Cass Lake, Minnesota, in June with the help of the Forest Supervisor of the Chippewa National Forest.

Tests made during the summer have confirmed the conclusion already reached that drought resistance could be induced by controlled watering and that this resistance persisted in the plant throughout the following year.

From fertilizing tests made in the nursery and greenhouse it would appear that plants physiologically deficient in some of the nutritive elements are hardier to drought than plants receiving an abundance of all the required elements.

In the tests nitrogen and phosphorous were applied to 1-0 red pine as ammonium sulphate and potassium phosphate in a variety of combinations. The seedlings in the greenhouse were potted in pure washed silica sand to which a standard tonic solution of magnesium sulphate, calcium chloride, boric acid, manganese sulphate, and iron chloride was added. The soil in the nursery was washed in a concrete mixer to remove organic matter, soluble salts, and fine material. Two watering levels were also maintained.

After three months, drought tests made on the greenhouse plants showed marked differences between nitrogen and phosphorous applications. The effects of watering appear to be masked by the greater effects of the fertilizers. The same trend was noted for the nursery stock although the phosphorous results were not consistent. Plants growing in beds receiving no nitrogen survived 7.59 days in the drought machine. The plants in beds receiving 1.1 pounds of ammonium sulphate per thousand square feet survived 6.14 days while those receiving monthly applications of twice that amount survived 5.48 days.

These results are significant but they are not conclusive. However, they would seem to indicate that the control of the nitrogen level may be an important feature in the development of drought-resistant stock.

Northern Rocky Mountain

Direct Seeding Tests. Though detailed figures on the eight Latin square direct seeding test plots established by Schopmeyer last fall and this spring are not yet available, it is outstandingly apparent that the seed spots which were given rodent protection have produced a good crop of seedlings. Practically all spots in the fall sown plots protected by conical screens contain live seedlings which in most instances made vigorous growth and suffered comparatively little from mortality during the initial season. Ponderosa pine on an exposed flat on the Kaniksu Forest made especially vigorous growth almost literally filling the conical screens. Germination of western white pine and ponderosa pine on unprotected spots was very sparse, a practical failure. Engelmann spruce, how-

ever, made a favorable showing on unprotected spots.

Seed spotting tests will be continued this fall by making fairly extensive tests of a poison mixture recommended by the Biological Survey. A strychnine, yellow dextrin, cornmeal, and plaster of Paris coating is applied to the seed, as chocolate is applied to peanuts. To give it a fair test and at the same time get some information on costs and technique, a 40-acre area and an 11-acre area are to be sown this fall using CCC labor. Applying poison to only a small area of an acre or two does not give a good test of its efficacy since no real impression is made on the surrounding rodent population. Next spring, it is planned to seed another 40-acre tract adjoining the one sown this fall.

Seed spotting tests of western red cedar are also being made this fall. Being very small, it is hoped that seed of this species will not be attractive to rodents.

A more complete report on the seed-spotting tests will be given at a later date.

Rocky Mountain

Lodgepole Pine Artificial Seeding. During the plantation survey of this year an area was visited on the San Juan National Forest which was artificially seeded to lodgepole pine in 1911. The partial success of this lodgepole pine seeding is of special interest as this species does not occur naturally so far south in the central Rocky Mountain region. Originally the seeding was reported as a complete failure, but as time progressed trees began to show on the more or less barren knolls and near scattered stands of aspen where the grass cover was sparse. The distribution of trees at present is uneven but the growth is satisfactory, the largest tree being 24 feet tall and 6 inches in diameter. Natural reproduction coming in near seed-bearing trees suggests that lodgepole pine is adapted to this locality in spite of the fact that it is well outside of its natural range.

Southern

Seed-Testing Laboratory. The Station's seed-testing laboratory has been moved to the Harrison Experimental Forest. The service testing of seed for the Region 8 nurseries will be done there, and Miss M. L. Nelson has been appointed to take charge of this work.

Southwestern

Woodland Type: Blighting of Pinon Nuts. Blighting or blasting of pinon nuts, or, more correctly, abortion of ovules or seeds, has been observed to be common at various stages in the 2-year period of growth. At intervals of 1 to 4 days during the growing season of 1938 material of ovules was collected at a plot near Flagstaff, Arizona. Detailed examination of microscopic stages of development of ovules, including these pathological stages and their causes is to be made from prepared slides this winter.

A few young cones die in the buds or shortly after they emerge about the middle of June, when pollination takes place. Abortion of ovules in several cone scales next to the lowest, sterile scales occurs in all pinon cones soon afterwards and is noticeable early in July. Although inconspicuous, mortality of ovules in this minute stage of about 0.5 mm. in length is high in all cones. Apparently these cone scales are covered by bud scales at the base of the cones during pollination and receive no pollen. Ovules of the two or three small cone scales at the upper end of the cones usually abort also.

From the middle of July to the first of September, the time growth stops for the year, additional ovules die when about 1 mm. or less in length. One or both of the ovules on a single ovuliferous scale may abort.

Abortion continues during May and June of the second year. The contents of some ovules become brown and shrivel up in the walled stage of the female gametophyte before fertilization.

The time abortion is most conspicuous is after cones and nuts reach full size, about the middle of July following fertilization about the first of July. From this time until the nuts become mature, about the first of September, many additional nuts start to blight. Blighting of full-sized nuts occurs when growing embryos are present and rarely after the embryos have become mature. The embryo dries up first and the endosperm gradually shrinks until it becomes a small hard mass in a seed coat of normal size.

Nuts with shriveled contents are easily distinguished from normal nuts in the same cone by their lighter or paler color. Empty nuts usually are much more numerous than normal nuts at certain warmer, drier localities near the lower altitudinal limit of the pinon zone. Occasionally the nuts will blight over a larger area and what was predicted to be a good crop turns out to be a failure. Empty nuts are distributed irregularly in cones with well filled nuts. Frequently a good and a bad nut will lie side by side at the base of the same ovuliferous scale.

Additional mortality of cones and nuts in both the first and second growing seasons is due to insects. A few small cones die in June shortly after pollination, when the twigs bearing them are killed by larvae of tip moths. In July and August some cones are destroyed by small hymenopterous larvae which live inside the cones and feed upon ovules and scales. Most of the insect damage occurs from June to August a year later, when the cones are nearly full size. Lepidopterous larvae bore holes into the cones and seeds and destroy the contents. These cones usually turn brown and fall to the ground, or if they remain on the trees, do not open. In places destruction of cones by insects becomes of considerable economic importance.

Ponderosa Pine: Seed Spotting. Approximately 160 pounds of ponderosa pine seed collected in 1936 was cleaned and graded into one-sixty-fourth-inch size classes with a Clipper Cleaner. The amount of seed in each class was weighed, the germination percent determined, and the first season survival of seedlings grown in seed spots representing each class was tested. The number of seeds planted to a spot varied with the germination percent. Enough seeds were planted to each seed spot so that 30 seeds would germinate on an average to a spot.

A summary of the findings is given in the table below:

Seed-Spot Survival

Size class, class interval 1/64 inch	Quantity of seed in pounds	Germination percent, aver- age of 10 lots of 100	Seedling survival, total of 10 spots
9	2.41	61.2	18
9 - 10	20.56	80.9	25
10 - 11	73.50	76.1	<u>24</u>
			67
11 - 12	33.16	83.6	43
12 - 13	20.50	76.2	49
13 - 14	<u>0.31</u>	73.9	<u>27</u>
			119
Total	150.44		186

The last column in the above table points to the advantage of large seed in seed spotting. It also verifies earlier work on the correlation of the size of seedlings with seed size, as there was a noticeable increase in the size of seedlings the first season with an increase in the size of seed sown.

Increasing the number of seeds to offset the lower germination of small seeds did not, as shown in the above table, result in the same number of seedlings surviving in each size class. While it is still too early to generalize on the ability of seedlings to survive, all evidence at present points toward the advantage of producing seedlings from large seeds.

The study also suggests that when both seed spotting and artificial planting are practiced, it would be well to use seed below average in size for nursery planting where growing conditions are maintained at an optimum, and reserve those over average size for seed-spot planting where optimum conditions cannot always be assured.

One difficulty in seed-spot planting is the control over the number of seedlings surviving to a spot. Years when rainfall is plentiful and is well distributed, germination and survival are excellent. Apparently, under these conditions some small as well as large seeds germinate and produce seedlings that survive, and often many more than are desirable to a spot. Seed that has been graded into size classes suitable to seed-spot planting should avoid this to a large extent, as large seeds will, as a rule, germinate and produce seedlings that vary mostly in size rather than in number with variations in growing conditions the first few years.

Douglas Fir: Seed Spot Preparation and Protection. In the fall of 1937 a plot of 5 acres (10 chs. x 5 chs.) was laid out within a selectively cut mature stand of Douglas fir and white fir. The plot was subdivided into 50 one-tenth acre blocks and within each block two screened seed frames (the locations of which were randomly selected) were placed for the purpose of obtaining representative samples of natural reproduction under protected and unprotected conditions. For the purpose of obtaining a check against the results of natural seeding, 4 small spots were artificially sown to seed around each seed frame. Two of these spots were "prepared" by spading the top soil and removing herbaceous vegetation, and two were left unprepared. One of each set of two spots was protected with a 1/2 inch mesh hardware cloth screen to protect the seed from rodents and birds. Ten Douglas fir seeds of local origin, and currently collected, were sown in each spot. In the prepared spots the seed was sown on exposed mineral soil, lightly covered and then capped with a thin layer of litter. In the unprepared spots the seed was simply scattered on top of the undisturbed litter, the aim being to simulate natural seed fall.

Results, as based on the last examination made on August 26, 1938, are shown in the following table. Instead of average number of seedlings per spot the results are expressed in terms of percentage of spots having different numbers of seedlings, such as one or more, two or more, etc.

TABLE 1

Results of Douglas Fir Seed Sowing
in Screened and Unprotected
and Prepared and Unprepared Spots
(100 Spots under Each Condition; Total 400 Spots)

Seedlings (a) per Spot	Screened Spots		Unprotected Spots	
	Prepared	Unprepared	Prepared	Unprepared
No.	Percent	Percent	Percent	Percent
0	9	10	44	43
1+	91	90	56	57
2+	82	73	29	33
3+	72	58	15	16
4+	61	45	9	8
5+	56	31	5	4

(a) Based on number of live seedlings as of August 26, 1938.

Although it is too early to say how large a percentage of the spots will be "successful" -- one surviving seedling per spot, of course, being sufficient -- it is for the present assumed that only those spots which now have three or more (3+) seedlings will remain in that class. Using the figures given under that classification, the following deductions may be made:

1. That preparation of the soil helps materially to insure a high percentage of successful spots.
2. That there is no advantage gained in seed spot preparation unless the spots are protected.
3. That without some means of protection the percentage of successful spots is likely to be too small to warrant the use of this method of artificial regeneration.

Washington Office

Excerpts from English summary of Gran - og furufrøets spir-
ing ved Forskellig temperatur og Fuktighed (The germination of
spruce and pine seed at various temperatures and degrees of moist-
ure) by Elias Mørk. From: Meddelelser fra Det Norske Skogforsøk-
svæsen 21 (2) 227-249. 1938.

The present work is a study on the effect of various combinations of temperature and moisture on the germination in spruce and pine seeds.

The germination took place in thermostats in special germinating vessels made of zinc. The soil in these germinating vessels consisted of finely crumbled humus. The seeds were covered with fine glass sand. The weight of the germinating vessels was controlled every fourth day. By giving the germinating vessel a constant weight, it was possible to obtain an equable degree of moisture in the germination stratum.

In each series, germination tests were started at 3 different temperatures, namely 10° , 15° , and 20° C, and at 4 different degrees of moisture of 20, 35, 50, and 70 volume percentages. In each series 12 germinating vessels were used in each of which were placed 1200 seeds in divisions of 100. The seed amounts in question were previously examined by means of germination analyses carried out in a Jacobsen germination apparatus.

When the germination tests at different temperatures and different degrees of moisture had proceeded for a period of 60 days, the temperature in all the thermostats was raised to 20° C, and the water content in the germinating vessels with the lowest degree of moisture, was increased to 40 volume percentage. This permitted the study of the capacity of the seeds to endure unfavorable conditions for germination.

Conclusions.

1. For the temperatures investigated, namely, 10° , 15° , and 20° C., the highest germination percentages are always obtained at 20° C., the germination period then lasting for about 2 weeks.
2. Poorly ripened spruce and pine seeds have higher temperature requirements than the same seeds well ripened. Of well ripened seeds about 50 percent of the living seeds are able to germinate at 10° C, although the germination takes about 5 weeks. Seeds poorly ripened do not germinate at a temperature as low as 10° C.
3. Pine seeds properly ripened germinate relatively better

at 10° C, than do spruce seeds of equal ripeness.

4. The moisture has a very great effect on the germination speed, as well as on the germination percentage. Of volume percentages of 20, 35, 50, and 70, 35 gives, as a rule, the highest germination percentage. As there is but little difference in the germination percentages at 35 and 50 volume percentages, the moisture optimum for germination must lie within this range.

5. Change in the moisture optimum with decreasing temperature has not been proved.

6. At a moisture of 20 volume percentage, the germination percentage is low and the germination proceeds slowly. With a water content of 70 volume percentage, the germination percentage is low, too.

7. Seeds lying in a soil, the temperature of which is too low to allow satisfactory germination, require a longer germination period the lower the temperature becomes. A great part of the seeds die during this period. The percent of dead seeds is lowest at the lowest degrees of moisture and becomes higher with increasing moisture.

8. Poorly ripened pine seeds maintain their germinating power better than do poorly ripened spruce seeds at low temperatures and with moistures below 50 volume percentage.

9. It appears from these germination tests that well ripened seeds have many advantages over poorly ripened seed. First, well ripened seeds are less exacting as regards germination temperature, and secondly, they keep better when lying in the soil under conditions unfavorable for germination.

FIRE PROTECTION

Allegheny

C.C.C. Fire Study. The C.C.C. forest fire study of 1937-38 in New Jersey brought to light the following pertinent data based on 186 fires occurring in 1937 in eleven of the thirteen Sections of Division B.

1. More than 45 percent of the fires were 1/4-acre or less in size at the time of attack and only 6.5 percent.

were 11 acres or more.

2. 75 percent of the fires were 50 feet or less from a road passable by truck at the time work began and only 12 percent were more than a thousand feet from country roads.
3. 44 percent of the fires were less than 5/10 of a mile from a water supply for refilling a 500 gallon tank on a truck, and only 4 percent were more than 2 miles from such a supply at the time of attack.
4. 18 percent of the fires were 100 feet or less from a water supply suitable for use in direct pumping with a portable pump while over 20 percent were more than a mile from such a supply at the time of attack.
5. 86 percent of the fires would have been better handled by a quick initial attack from a tank truck rather than from a pump.

This information shows definitely that tank trucks could have been used very advantageously on these fires.

Under the new cooperative study in New Jersey a method of mapping roads and water supplies was developed during the summer. Following the method which the Station developed in the vicinity of the Lebanon Experimental Forest the regular State protection organization is mapping a number of other Sections.

The 50-foot weather tower erected on the Lebanon Experimental Forest and additional recording instruments were obtained in order to carry on the fire-weather recording and testing of the Region-wide (Region 7) fire-danger meter for coastal plain conditions in New Jersey.

Appalachian

Fire Danger Measurement. The most important development in fire danger measurement research at the Station since the latest report has been a major development of the Appalachian fire danger meter into a device intended to apply in the Green, White, and Allegheny Mountains, as well as in the Appalachians.

Since one danger meter is desirable in all parts of a fire control unit, fire men of the three stations within the geographical boundaries of Region 7 (Northeastern, Allegheny, and Appalachian) met in August at New Haven to discuss the possibilities of producing such a device. The Appalachian Station, represented at this meeting by Nelson and Jemison, was assigned the job of preparing an all-Region 7 meter, the first attempt to develop one meter for use in the mountains of the East.

The new meter integrates the following factors into a scale

of five danger classes: (1) fuel moisture, (2) wind velocity, (3) season of the year, and (4) condition of lesser vegetation. The factors are measured and defined in such a way as to permit flexibility and recognition of differences caused by the wide geographical range of the several mountain groups.

An important feature of the new meter is a fire danger forecasting mechanism, by which not only today's conditions in fire danger classes are expressed, but danger 24 hours in advance is predicted in the same terms. A check of danger forecasts indicates that the meter will predict correctly about 70 percent of the time. Correct predictions for individual months ranged from a low of 60 percent to a high of 77 percent.

Because of extremely rapid fluctuations of danger from day to day, a predicting mechanism that helps to eliminate personal error associated with individual prognostication should be a material aid to those responsible for fire control organization. The new danger meter will be tested at approximately 50 stations during the coming fall fire season.

Paul Goodwin has been detailed to the Station by Region 8 and is beginning field work planned to lead to the development of a danger meter suitable for use in the Coastal Plain. His work at the Santee Experimental Forest in South Carolina will include studies of fuel moisture and weather relations, tests of various methods of measuring fuel moisture, and fire behavior studies.

Byram has conducted extensive tests with the "artificial suns" described in the preceding report (p. 24) and has established rate-of-drying curves and moisture equilibria for natural fuel under various controlled conditions. These data will permit a more precise evaluation of the effect of season of the year on fire danger than has ever before been possible. Byram has also found numerous relations of interest. For example, under certain conditions when fuels are in the sunlight, wind slows down the rate of drying and maintains significantly higher moisture equilibria than are found in calm air. The reason, of course, is that the cooling effect of the wind more than offsets its drying action on the fuels.

Hendrix has completed the construction of the six fire-weather stations located in pairs at 2300-, 2800-, and 3300-foot elevations on a line transecting a mountain valley in the Bent Creek Experimental Forest. Some of the recording instruments have been calibrated and recently installed.

The effects of altitude and aspect upon the fire danger factors will be studied at these new stations. The information obtained will be particularly helpful in the future establishment

of danger station networks and in the modification of ratings obtained at established stations.

Fire Damage. Craig and Watts spent most of the summer conducting the annual reexamination of permanent fire damage plots. Computations show that the effect of a light fall fire on mortality continues in mixed hardwoods at a diminishing rate for at least four years. It is planned to summarize all available mortality data this winter.

The fire project has been cooperating with Forest Pathology on a continuation of last year's cull study. Warlick and Garren have been in the field since early June obtaining data on the amount of cull caused by decay entering through basal fire wounds. Indications are that this study, supervised by Hepting, will produce data of particular value in damage appraisal work.

The effect of fire wounding on subsequent diameter growth, studied in white oak earlier in the year, is being investigated on a wider scale this fall. The growth of other important species before and after fire wounding is to be checked on several areas. The study of white oak showed that even large wounds, involving as much as 75 percent of a tree's circumference, had no retarding effect on diameter growth.

California

Fire Behavior. Fire behavior research on the Shasta Experimental Forest has been concentrated during the present field season on study of fuel as a factor of fire behavior, on the study of fuel moisture trends in living and dead brush fuels, and on studies of wind movement. To facilitate the study of fuels a wind tunnel with an 8'x8' test section was constructed on the forest during the past summer. This apparatus will be used to test present theories of fuel measurement under conditions of air movement. Although designed and built with fuel studies in mind, the tunnel will have wide application to other phases of fire behavior studies, both spread and ignition.

Studies of the variation in fuel moisture of green vegetation in brush fields as a factor in brush inflammability were begun in 1937, resulting in a series of curves showing average moisture content of leaves of all species throughout the season. This work is being replicated with certain refinements during the present season. In general, a close correspondence has been noted between the moisture content of green leaves during the two seasons. In addition to the data on moisture content, a careful record has been maintained of the development and dropping of foliage on selected brush specimens. These data will provide the basis for estimating the total

amount of green foliage present at any season on typical brush areas.

Work on behavior studies has been interrupted to an unusually large extent by the occurrence of large fires on the Shasta forest requiring the services of the research crew.

Fire Control. Work on fire danger rating has been rapidly pushed ahead through installation of approximately 150 new fire danger stations on 8 national forests. With these installations completed, 12 of the 16 California "fire" forests are equipped for fire danger rating. One man has been steadily engaged in aiding in the installation of fire danger rating equipment and in the inauguration of the system on the national forests.

The work of coding the past 10 years' fire reports and transferring the coded information to punch cards has gone steadily forward and is now virtually completed. These records are to be used in the replanning project and for the planned analysis of southern California fire statistics.

Field studies were inaugurated in southern California during the present season in the study of the visibility problem. For the present the study is designed to determine the type of visibility measuring device most applicable to visibility measurement under southern California conditions.

The Experiment Station personnel participated to a limited extent during the field season in two cooperative studies on the Shasta Forest. During late August and early September tests on the effectiveness of chemical solutions were made by the Forest Products Laboratory group on a series of test fires within the Shasta Experimental Forest. Recently the airplane fire control study under the direction of Fred Funk of the Regional Office has been working in the vicinity of the Pilgrim Creek Station. Following preliminary study of trajectories of dropped objects and experiments in the dropping of containers on targets, tests will be made in the "bombing" of small spreading brush fires.

Lake States

Protection Planning. At the request of the Regional Office, tables have been prepared giving the minimum size of crew required and the probable size of fires when corralled under present regional control standards, for various combinations of travel time, rate of spread, and resistance to control. These tables make possible the determination of man-power requirements on a uniform basis. While not intended for dispatching, they should be found useful as a dispatching guide since they give the average man power required based on past experience and indicate the rela-

tive strength of attack called for under various conditions.

Danger Meter. During August, State and Federal forest officers in Minnesota, Wisconsin, and northern Michigan were visited and interviewed as to the application of Lake States danger meter to their locality in an effort to determine its limitation and weaknesses as a basis for its improvement. The reaction to it was found to be unusually favorable. Both State and Federal agencies have been using it with marked success and report a decided saving in protection costs as a result. While not always agreeing with it in every instance, the consensus of opinion is that it is a big help in sizing up conditions. The Manistee reports, for example, that without it they would have been unprepared for a serious outbreak of fires this spring, while the Upper Michigan stated that it had saved them many times its cost by indicating when lookouts could safely be dispensed with. Note was made of criticisms and suggestions offered in regard to it and of circumstances under which it apparently over- or under-rated current danger. These will be studied and taken into consideration when it is revised. In view of the general satisfaction with it as it stands, however, and the relatively mild season under which it has been in use, no general revision will be attempted until it has had a more thorough trial. While the meter can unquestionably be improved upon, no serious weaknesses have developed to date and we are encouraged to believe that it is basically sound.

Northeastern

Detection: The final report of the White Mountain National Forest detection study was submitted to the Regional Forester's office early in July. This report was so well received by both the Regional Forester and the Supervisor of the White Mountain National Forest that its recommendations are being adopted in revising the entire detection system on the Forest, which is under way at the present time.

Fire Danger Meters. During August, Nelson and Jemison of the Appalachian Station and Little of the Allegheny Station spent several days with Stickel working out the details of an All-Region 7 forest fire danger meter. This project was undertaken at the request of the Office of Fire Control of Region 7. A comparison of fire-danger data obtained from the Northeastern and Appalachian fire-danger meters showed that there was good agreement between the two meters as far as general trends are concerned, but that our meter gives consistently higher readings than does the Appalachian meter, a variation which is not inconsistent in view of the fundamental difference in the basic data on which the two meters are based. Since it appeared impossible to harmonize the two meters into one single device, it was agreed that Jemison would devise

a new meter, using all available fire-weather data of the North-eastern and Appalachian Stations. It is hoped that this new meter will be issued this fall in time to be given a preliminary trial throughout Region 7.

Fire Glossary. During September, Curry of the California Station was able to spend several days at the Station discussing our fire work in general. This visit gave Stickel an opportunity to outline plans with Curry for the final revision of the fire glossary material that was collected last year. Arrangements have been made with Mr. Headley's office for Stickel's committee to assume responsibility for all the strictly technical terms in the general All-Service forest fire glossary. This is a task which every effort will be made to complete this winter.

Fire Damage. All of the basal wounding permanent plots were reexamined early in July. Although the peak of delayed mortality has now passed on all of the plots, a few trees on plots that are five years old were found to have died since last year's examination. On some of the older plots decay has progressed to such a degree on individual trees that blow-downs are becoming increasingly common.

Northern Rocky Mountain

Chemical Analysis of Plant Species. Chemical analyses of several typical species of green grasses, forbs, and shrubs were again made at 10-day intervals at Priest River during the past fire season. A report showing the preliminary results has been completed by Dr. Richards and is now ready for publication. A comparison of the data for all four seasons of this work remains to be made.

Fire Danger. Data for a fifth season, in the study of fire danger factors by altitude and aspect, were obtained by Hayes. Two reports are planned for early publication. The first will cover in detail all the technical features and is intended for the Monthly Weather Review. The second will be confined to the practical uses of this information, using the Review article as a source of references, and is intended for the Journal of Forestry.

Micro-Meteorological Stations. The five micro-meteorological stations sampling conditions from ground level up through the forest canopy to a level 150 feet above ground and 60 feet about the forest canopy have now been completely equipped and were operated for a part of the past season. This study utilizes our 150-foot steel tower at Priest River, located without cutting any trees within a dense timber stand of 80-year age class.

Pacific Northwest

Fire Control Planning and Fire Danger Rating. Fire control planning and fire danger rating were the major activities. The sample ranger district plan for the coordination of facilities for detection, transportation, and manning on a strength-of-force and cost basis was completed. The procedure from this point forward will be decided in conferences with Region 6 fire control men as soon as an extremely busy fire season comes to a close. A statistical analysis was made which indicates that the probability of occurrence of smcker and camper fires is four times greater in areas having a considerable mileage of roads than in areas without roads. Analysis of Byran haze meter visibility measurements revealed that the distance at which lookouts can see a small fire is restricted to 10 miles or less on 48 percent of the days west of the Cascade Range and is thus restricted on only 22 percent of the days east of the Cascade Range. The day-to-day operation of the fire danger rating system--fire danger stations, fire danger board, etc.--has been followed closely in order to discover wherein it could be improved. Several small studies of fire danger rating problems were made, including tests of the ignition of forest fuels by such agents as cigarettes and matches, and considerable attention is being given to planning future work. In cooperation with the field unit from the Forest Products Laboratory tests were made of the practicability of using chemicals in putting out fires in forest fuels. Rate of spread of fire and its relation to fuel moisture content, wind velocity, and other variables was systematically observed on several fires.

Southern

Fire-Danger-Meter Study. The frequent occurrence of wild fires in the longleaf and longleaf-slash pine types of the Gulf States, the relative ease of controlling test fires under even moderately severe burning conditions, and the comparatively uniform fuels have made it feasible for the Southern Station to attack the fire danger-meter problem in a more direct manner than is usually possible. The attempt has been made, therefore, not merely to define fire danger under a specified set of weather and fuel conditions as low, moderate, high, extreme, etc., but to provide an estimate of the perimeter of a fire and the rate at which the perimeter is spreading at any time after its origin. It is recognized that the results obtained in the South are not directly applicable in other regions but it is thought that some of the relationships found (for example the relative importance of wind velocity and fuel moisture as factors affecting rate of spread) may be of assistance in fire studies at other stations, and particularly that they may provide a basis for checking the integration of factors used in hazard rating. For this reason the methods and results will

be discussed at some length.

Following a preliminary study in the spring of 1937, during which measurements were taken on 55 test fires to develop a suitable technique, a specially equipped 4-man crew was in the field throughout the fire season from November 1937 through April 1938. During this period measurements were taken on 250 test and wild fires in the longleaf and longleaf-slash pine types, and on 75 test fires in the shortleaf-loblolly-hardwood type.

It was felt from the beginning that neither test fires nor wild fires alone could suffice, because of the lack of data on discovery time and early spread in the case of wild fires, and because of the undesirability of setting test fires under extreme conditions or of allowing the test fires to become large enough to be dangerous or difficult to suppress. In general, the test fires were not allowed to spread to more than two acres in size.

The study crew consisted of an instrument man and three mappers equipped with a specially fitted pick-up truck. In addition to fire-suppression equipment the crew was supplied with mapping and timing devices, weather-measurement instruments, fuel- and soil-sample containers, and an instrument for determining moisture content. Measurements taken on each fire included the perimeter (which was mapped at 1-, 2-, or 5-minute intervals, depending on the rate of spread), wind velocity and direction at 1-minute intervals, a continuous record of relative humidity and air temperature, and the moisture content of both the fuel and the top inch of soil. At the conclusion of the rate-of-spread measurements on the test fires, and when the suppression crew arrived on the wild fires, measurements were taken of the rate of held-line construction according to the portion of the fire attacked, the crew size, and equipment.

Obviously, more information was taken on each fire than can possibly be utilized by the ranger in fire-control organization planning, or by the dispatcher in crew estimates. This information will be necessary for later, more intensive fire-behavior analyses, but so far only those measurements that can readily be utilized by the fire-control organizations have been used.

In order to take advantage of the high correlation between successive perimeters of the same fire and to reduce the computational work involved in the analyses, an attempt was made to fit curves to perimeter and time data, thus creating but one observation per fire. Considering the fact that a fire spreads at every point and therefore that a percentage relationship probably exists between successive perimeters, and also from empirical trials, the curve type selected and found to fit well was

$$P = Kt^b \quad (1)$$

$$\text{or } \log P = \log K + b \log t \quad (2)$$

where

P is the perimeter of the fire at time t , and K and b are constants to be determined from the individual fires. Geometrically, K is the perimeter of the fire at one minute, and b is the slope of the straight line relating $\log P$ with $\log t$.

The first step in the analysis was to fit a curve of type (2), by the method of least squares, to each test fire. Because of the relative unimportance of variation in perimeter at one minute, and because it greatly facilitates subsequent computational work, the average K value obtained was used throughout and a new b value was determined for each fire with this condition imposed. The new curve based on these K and b values was plotted for several fires and the goodness of fit apparently was little impaired. In essence, then, all that is needed to determine the rate of spread of a fire is to determine the b for the given burning conditions. To do this, b was correlated with the various weather and fuel measurements for each fire.

In order to make use of the data on wild fires, it was necessary to determine the time between origin and the measurement of the first perimeter. This was done by estimating the time necessary to reach that perimeter from the measured fuel and weather factors and the relationship described above. Including the wild fires, b was then correlated once again with the fuel and weather measurements taken on each fire. The equation obtained was

$$b = .1123 W.V. - .0082 F.M. + .7512 F.D. - .0344 A.R. + .7353$$

where W.V. is the average wind velocity in miles per hour,
F.M. is the fuel moisture content in percent (dry-weight basis),

F.D. is the fuel density on a scale of .1 to 1.0
and A.R. is the age of rough or the time since the last fire, in years.

All of the regression coefficients were highly significant, with $t\beta$ values of 15.16, 10.23, 6.66, and 2.86, respectively. The relative importance of these factors is measured by the beta values which were +.5644, -.3816, +.2775, and -.1183 respectively. Within the range of the data, wind velocity is evidently about 1-1/2 times as important as fuel moisture in influencing rate of spread. It is important to note also that when fuel moisture is introduced neither relative humidity nor season (which affects rate of spread through the quantity of green vegetation) has a significant effect.

Taking advantage of the linear relationship between perimeter in chains and time in minutes (logarithmic scale), a rate-of-spread indicator has been designed which will show the perimeter at any given time for any given wind velocity, fuel moisture, density of fuel, and age of rough.

Hazard Indicator Stick. Following preliminary tests of 59 samples, made in various sizes and shapes from 17 species of wood and other materials, the most promising materials were tested intensively in a study of the hourly relationship between fuel moisture and the moisture content of a hazard indicator stick. For a period of three weeks during the winter fire season, fuel samples were collected at hourly intervals throughout the day and the dry-weight moisture content of each was determined. As nearly as possible at the same time, the indicator sticks were weighed.

Preliminary graphs showed changes in the moisture content of a rattan mat to be most closely related to the changes in moisture content of the grassy fuels. Even the rapidly changing moisture content of the rattan, however, changes less rapidly than did the moisture content of the fuel, hence it was necessary to introduce provisions to take account of this lag. The analysis employed was as follows: the difference between fuel moisture content and indicator moisture content was correlated with (1) indicator moisture content, (2) difference between present indicator moisture content and that one hour past, and (3) number of hours since 5:30 a.m. After adjusting the relationships for a strong curvilinearity between the difference and time of day, and for a joint correlation that occurred, the correlation between actual and estimated fuel moisture content for the entire day was 0.86 and the standard error of estimate was 16 percent. For the critical part of the day, i.e., 10:30 a.m. to 6:30 p.m., the correlation was 0.82 and the standard error of estimate was 8.6 percent.

Since the curve of difference over time of day was found to be a horizontal straight line between 10:30 a.m. and 6:30 p.m., a single table suffices for this period. This table and examples of its use are as follows:

Longleaf Pine-Grass Type
Vegetation Dead
Time 10:30 a.m. to 6:30 p.m.

FUEL MOISTURE CONTENT TABLE
(to be used with rattan mat hazard indicator stick)

Present Stick Moisture	Present Stick Moisture Minus Stick Moisture One Hour Past											
	-25	-20	-15	-10	-5	0	5	10	15	20	25	
Percent	Percent (dry weight basis)											
5				15	15	16	17	21	27	36	46	
7.5				17	18	18	20	24	32	40	50	
10		20	20	20	21	24	29	37	46	56		
12.5		22	22	23	24	27	33	42	50	60		
15		25	25	26	27	31	37	46	56	66		
20	30	30	30	31	34	38	47	55	65	77		
25	35	35	36	37	41	47	56	65	76	87		
30	40	40	40	41	44	48	57	65	75	86	98	
35	45	45	46	47	51	57	66	75	86	97	110	
40	50	50	51	54	58	66	75	85	96	108	122	
50	60	61	64	68	76	85	95	106	118	131	145	
60	73	78	86	95	105	116	128	141	155			
70			105	115	125	138	151	164				
80					147	160	174					

J.G.O. - 9/21/38

Examples of use:

1. Stick Moisture at 10:30 a.m.----- 40 percent
 Stick Moisture at 11:30 a.m.----- 30 percent
 Present stick moisture minus stick moisture one hour
 past----- 10 percent
 Fuel moisture content 11:30 a.m.----- 41 percent

2. Stick Moisture at 10:30 a.m.----- 20 percent
 Stick Moisture at 11:30 a.m.----- 30 percent
 Present stick moisture minus stick moisture one
 hour past----- 10 percent
 Fuel moisture content 11:30 a.m.----- 65 percent

Separate tables were prepared for two periods, preceding and following this critical period: one table for 8:30 a.m., and one for 7:30 p.m. All of the tables, and especially the one shown above, will be used to estimate current fuel moisture content in rating fire danger.

FOREST GENETICS

Northeastern

Pedigreed Stock. Facilities have been developed during the past summer at the Hopkins Memorial Experimental Forest for the handling of seedlings obtained from controlled pollination. All of the pedigree stock which was started in the greenhouse in New Haven has been transferred to Williamstown and is now growing in cold frames.

Polypliody. Colchicine treatment of seeds to induce polypliody in forest trees has apparently produced results in the case of silver maple. Peculiarities of growth have been observed in the seedlings, which seem to indicate the occurrence of at least islands of polypliod tissue. Growing shoots of hybrid poplars treated with colchicine also give evidence of induced polypliody. Cuttings will be made from these poplar shoots in an attempt to produce polypliod plants.

Vegetative Propagation. Experiments in vegetative propagation during the past summer under outdoor conditions yielded successful results in the rooting of cuttings of several forest tree species; namely, sugar maple (as high as 80 percent), basswood (25 percent), and red maple (70 percent). Greenwood cuttings of white pine failed to root under outdoor conditions with the treatment used.

Botanical Descriptions. Botanical descriptions have been prepared of poplar hybrids which have never been distributed, of the same parentage as the McKee hybrids for which patents have been granted. These descriptions will be used during the coming winter for patent applications on these hybrids.

Cooperation. Within the last month contact have been made with Dr. Sax, in charge of forest tree breeding for the Cabot Foundation at Harvard, and Dr. Johnson, in charge of the Forest Genetics project of the Canadian Forest Service, on cooperation between the three forest genetics research projects in the North-

east. Dr. Sax and two assistants, as well as Dr. Johnson and Dr. Heimberger, visited the Oxford Nursery and spent a day going over the hybrid poplar work. Arrangements have been made for close co-operation.

RANGE INVESTIGATIONS

GRAZING MANAGEMENT

California

Foothill Ranges; Supplemental Feeding. (In cooperation with University of California). The first experiment concerned with supplementation of young animals on dry forage was completed in July. Up until the time the first calves were weaned, all the animals on the Range had been treated alike. Then the calves were divided into two equal lots based on weight, grade, and sex. The calves in the group to be supplemented averaged 428 lbs.; those to be unsupplemented averaged 429 lbs. The first group was supplemented through two dry seasons and winters.

The supplemented group again was given concentrates, chiefly cottonseed cake, for 5 or 6 weeks just previous to shipping them to market. All the supplementing for the three periods was done at a total cost of \$21.70 per head. When the groups were sold in South San Francisco, at about 30 months of age, the supplemented animals averaged 1,141.5 lbs. and the unsupplemented 910.3 lbs. The supplemented lot sold for \$8.75 per cwt.; the unsupplemented for \$7.50. Selling at price of \$31.60 per head, the supplemented animals brought a net amount of \$9.90 per head, after deducting feed costs. The supplemented animals dressed out around 59 percent and the unsupplemented around 53 percent. No record was kept of labor costs involved with the feeding, since this would vary with each range set-up.

The preliminary results already obtained from this experiment clearly indicate that cattlemen should give serious consideration to the possibility of supplementing dry range forage in this region.

Pine Range: Livestock Weights as Related to Season of Use. The opening and closing dates of a grazing season for a range type are influenced by two important considerations - first, whether or not a desirable vegetative cover can be maintained under conservative use for the season designated, and second, the trends in live-

stock weights during the season.

Three years' data bearing on the latter point have been gathered on the Burgess Spring Experimental Range. This range, of 537 acres is grazed by cattle, and is located in cut-over ponderosa and Jeffrey pine. Most of the feed on the area consists of grasses and herbs. Festuca idahoensis, the dominant grass, makes up 21 percent of the total forage. Sitanion hystrix (10 percent) and Carex sp. (5 percent) are also important. Wyethia mollis (13 percent) is the dominant broadleaf herb, but is relatively poor feed. Lupinus calcaratus (6 percent) is probably the most valuable broadleaf species. Purshia tridentata (only 3 percent) is the only shrub of high forage value.

Weights taken at approximately two-week intervals during the past three years show that in each year the livestock stopped gaining in weight some time in the latter part of September - in 1936 on approximately September 15, in 1937 around September 27, and in 1938 again about September 15. Daily gains in weight dropped gradually from the first weighing to the end of the season, although the animals were not placed on the area soon enough in the spring in any of the three years to show when gains in weight might have started following the start of forage growth, and therefore the beginning of the grazing season from the standpoint of animal weights could not be determined. However, the closing date is pretty well indicated.

It should be noted that in 1936 there were 15, and in 1937 there were 16 head of cattle on the area whereas in 1938 there were 30, or twice as many. Utilization at the end of the grazing seasons in 1936 and 1937 was moderate, but in 1938 the range was distinctly overgrazed. In the first two years the failure of the cattle to gain after September 15 and 27 respectively was apparently due to the reduced quality of the remaining forage, which in amount appeared sufficient to carry the cattle a few weeks longer without overgrazing. In 1938 most of the feed was consumed by September 16, and no doubt both the shortage of the feed and its quality determined the date when the livestock finally stopped gaining in weight. The first two years' data point to the probability that the quality of the forage may be an important factor in determining the end of the grazing season, at least from the standpoint of animal weights.

Many of the allotments in the Eastside pine region of California, especially on the Lassen and Plumas National Forests, are made up primarily of three broad vegetative types, namely, meadow, sagebrush, and timber (cut-over and virgin). On many cattle ranges there is general over-use of the low-lying meadows and bordering sagebrush areas, and relatively light use of the timber types on the mountain slopes. This uneven use is due in

some degree to the presence of stock water in the meadows and low-lying areas, and the general lack of it in the timber. Furthermore, there is very little fencing to facilitate livestock distribution except along allotment boundaries. Riding is not a general practice, and proper salting plans have been hard to put into effect. Since proper season of use is an important factor determining the best coordinated use of these types, the findings of this study to date have a direct bearing on improved management of range allotments in this region.

Intermountain

Natural Revegetation. Plans are being made for the final step in the Great Basin's program of evaluating its mass of accumulated data. This will be a study of the life histories of native range species, based on data from many permanent quadrats and larger plots. The search will be for any ecological facts whatever, but will be pointed especially toward ascertaining the rate of recovery of depleted mountain range.

Earlier steps in the cleanup program have been publications on the local climate, results of early reseeding trials, and conclusions from fundamental physiological studies. In addition, before leaving for school, Price had a second physiological paper dealing with range readiness, and another on browse utilization - all in the final stages of preparation.

The projected analysis and summarization of ecological studies will be based on data accumulated over many years. New field work will not be undertaken until the job is done, for its findings - and its lack of findings - will guide the formulation of a renewed effort to comprehend the life histories and interactions of native range plants.

Utilization Standards. During the past summer the Region 4 Tentative Range Utilization Handbook was distributed to the field for checking by rangers and other range men. As a basis for measuring percentage utilization for further checking these standards a volume-height study, similar to the investigations previously made in Region 1 and 3, was initiated at the Great Basin Station.

Mature plants of the key species common to these summer ranges, and the most important secondary species, were harvested at ground level, dried and later sectioned into 1-inch lengths and weighed. Plants were harvested from the oak-brush zone, aspen-fir zone, and spruce-fir zone, ranging in elevation from 6,500 to 10,300 feet. Ungrazed plants from the grazed range were selected at random, so far as possible, from a number of sites within each

zone. Weights and percentages were recorded individually for each plant by zones for further studies, by height classes, and to note variability from year to year as may be influenced by climatic fluctuations.

In comparing these results with established concepts of 75 to 80 percent utilization of the key species as proper use for these ranges it shows a surprisingly small amount of stubble left on the ground. The following table presents these values.

Average height of stubble remaining when 75, and 80 percent of the volume of important forage plants of the summer range is taken. (Average for all zones.)

Species	Inches left when volume taken is:	
	75 percent	80 percent
Agropyron pauciflorum	2.96	2.36
Agropyron spicatum *	2.81	2.30
Bromus carinatus	3.61	2.92
Bromus inermis**	3.36	2.72
Poa fendleriana	1.30	1.02
Poa pratensis	1.95	1.55

*Occurs only in the oak-brush zone.

**Introduced in artificial reseeding plantings and is becoming established in many places.

Definite conclusions as to what degree of use constitutes proper use for these species cannot be drawn from these studies to date. Further investigations must be made in order to determine the average stubble height which must be left at the end of the grazing season in order to insure the maintenance of the important forage plants in a vigorous condition capable of making maximum sustained forage yields.

Field Day at U. S. Sheep Experiment Station. In June a highly successful field day was held by the Intermountain Station at the U. S. Sheep Experiment Station, Dubois, Idaho, in cooperation with the Bureau of Animal Industry and the Extension Service of the University of Idaho.

Nearly 300 stockmen and technical workers from the various federal departments and from the States of Idaho, Oregon, Utah, Nevada, and Wyoming assembled on the morning of June 9. These men, and some women, viewed the various grazing experiments and reseeding studies conducted by the Intermountain Station and some of the animal husbandry experiments conducted by the Bureau of Animal Industry. The excursion was under the direction of Dr. Stewart and Pechanec.

On the morning of June 10 the Bureau of Animal Industry staff, under the direction of J. E. Nordby, Director of the new Sheep Experiment Station and Wool Laboratory, explained both the work in operation and the new work that is contemplated. The final session was conducted on one of the reseeding plots where it was shown that a piece of abandoned cultivated land had increased in forage production approximately four times.

The experiments visited and explained consisted of (1) comparisons between spring and fall grazing, (2) rotation grazing during the spring period, (3) deferred rotation grazing, (4) the effect of removing sagebrush by burning, (5) the effect of grazing management on the open range, and the sheep being handled under systematic grazing, (6) wool exhibits at the laboratory, (7) animal husbandry experiments conducted by the Bureau of Animal Industry, and (8) reseeding experiments on abandoned cultivated land.

Stockmen Visit Reseeding Plots. A half-day excursion to visit reseeding plots in Boxelder County, Utah and Oneida County, Idaho was held in June by the Station in cooperation with the Utah Agricultural Experiment Station and the Utah Extension Service. Fifty farmers and stockmen and seven county agricultural agents attended. The new seedings showed the comparative stands of grasses obtained on abandoned dry farm lands from different species planted in the fall and spring at different depths. Dr. Stewart and A. C. Hull explained the experiments for the Intermountain Station and Professor Bracken for the Utah Agricultural Experiment Station.

Rocky Mountain

Resurvey of shortgrass ranges. Cooperating with the Bureau of Agricultural Economics, the station completed a vegetation cover survey of the BAE project near Briggsdale, Colorado during the 1938 field season. This work consisted of an original survey of some 70,000 acres of range land and a sample resurvey of 147,000 acres previously surveyed in 1936. The chief purpose of the resurvey was to determine what changes, if any, had taken place in range conditions in the last two years as a basis for possible adjustments in stocking rates on range lands in and around the proposed Central Plains Experimental Range. Using the same method of survey, the 1938 measurements were recorded for direct comparison with the 1936 measurements for the sample area.

Analysis of these data confirms the observations of most of the stockmen in the area that grazing capacity has declined, owing to a decrease in density of blue grama and buffalo grass. The less palatable grasses such as red three-awn (Aristida longifiseta), needle-and-thread (Stipa comata), dropseed (Sporobolus cryptandrus), and ring muhly (Muhlenbergia torreyi) have held their own or increased

slightly. The palatable shrubs, fourwing saltbush (Atriplex canescens) and winterfat (Eurotia lanata) have decreased in abundance while broom snakeweed (Gutierrezia sarothrae) and pricklypear (Opuntia polyacantha) have densities as great or greater than those recorded in 1936.

A large part of the 1938 spring and early summer growth on these ranges, which called forth considerable public press comment concerning improved ranges, consisted of non-palatable annual weeds such as pepper grass (Lepidium densiflorum) and stickseed (Cryptanthe crassisepala). These species matured and dried up in mid-summer, giving the range a decidedly "burnt out" aspect.

The following table records the average densities of the principal species found on the grama-buffalo grass range sample area in 1936 and 1938.

<u>Species</u>	Density (%)	
	<u>1936</u>	<u>1938</u>
Bouteloua gracilis	5.438	4.043
Buchloe dactyloides	1.938	1.218
Agropyron smithii	0.053	0.011
Aristida longiseta	0.139	0.145
Stipa comata	0.006	0.011
Muhlenbergia torreyi	0.009	0.015
Sporobolus cryptandrus	-	0.015
Cryptanthe crassisepala	-	0.038
Aster tanacetifolia	0.036	-
Eriogonum spp.	0.009	0.008
Bahia oppositifolia	0.015	0.023
Sphaeralcea coccinea	0.015	0.002
Salsola pestifer	0.017	0.008
Atriplex canescens	0.047	0.039
Eurotia lanata	0.023	0.006
Gutierrezia sarothrae	0.015	0.015
Opuntia polyacantha	1.175	1.486
Yucca glauca	<u>0.034</u>	<u>0.000</u>
Total density	8.988	7.107

These changes in range condition are representative for large areas of range lands in southeastern Wyoming and northeastern Colorado.

Western Range Survey. Final analysis of range survey data and completion of county reports was accomplished on July 1 by the Western Range Survey for Colorado and Wyoming. Range survey

materials from 31 counties, 11 in Wyoming and 20 in Colorado, were compiled and mapped for a total area of 16,864,641 acres. Two detailed reports for the sample counties, Baca in Colorado and Converse in Wyoming, and briefer generalized reports for the remaining counties were prepared and distributed to cooperating agencies.

Forage conditions studied on Manitou Experimental Forest.

A forage inventory of suitable pasture areas available in the Manitou Experimental Forest has been completed as a basis for the working plan for a proposed cooperative project between the Divisions of Forest Influences and Range Research. Basic information on forage conditions of the area is needed before the size of pasture, rates and season of stocking, and intensity of utilization can be worked out.

Southwestern

Shrub Invasion Control: Burroweed. The 50 small test plots (.02 acre) subjected to 25 various burroweed eradication treatments during the middle of May (see page 28, Monthly Report for May 1938 for burroweed densities) were carefully examined during September to determine percentage of kill (table 1). Re-check counts will be made in May 1939 to ascertain not only the percent of burroweed kill but also the effect of the treatment on other vegetation, mainly perennial forage plants.

The greater percent kill on the plots at Station No. 130 than at Station No. 131 was likely due to greater amount of chemical per plant since there were fewer plants on the plots at Station 130. Furthermore, the mechanical treatments show little or no difference in percent of kill between the plots at the two stations. A 90 percent kill is regarded as being satisfactory, so it is surprising to note the effect of mowing or clipping the burroweed plants to a height of 1 or 2 inches. This treatment resulted in 93.2 percent kill at Station 130 and 97.3 percent kill at Station 131. Diesel oil 27°+ A.P.I. proved superior to other petroleum oil sprays.

Table 1. --The effects of various mechanical and chemical treatments on burroweed (Aplopappus fruticosus)

Treatment	Station No. 130			Station No. 131		
	Date of treatment	Number of plants treated	Percent of plants killed	Date of treatment	Number of plants treated	Percent of plants killed
Grubbing	5/12	124	100.0	5/13	281	100.0
Mowing	5/13	161	93.2	5/11	410	97.3
Burning	5/13	102	100.0	5/12	490	100.0
2.5% H ₂ SO ₄ 1/	5/12	80	57.5	5/12	544	37.7
5.0% "	5/12	119	83.2	5/12	340	40.0
7.5% "	5/12	128	92.2	5/12	416	53.6
10.0% "	5/12	76	98.7	5/12	403	67.2
5.0% Atlacide	5/13	102	84.3	5/13	426	71.8
10.0% "	5/13	103	99.0	5/13	337	64.1
15.0% "	5/13	123	100.0	5/13	371	89.2
20.0% "	5/13	111	100.0	5/13	417	90.9
25.0% "	5/13	136	100.0	5/13	406	98.5
5.0% NaClO ₃	5/13	173	73.4	5/13	397	53.1
10.0% "	5/13	118	99.1	5/13	520	76.9
15.0% "	5/13	65	98.5	5/13	459	82.3
20.0% "	5/13	90	100.0	5/13	437	59.0
25.0% "	5/13	41	97.6	5/13	333	94.6
Borate-NaClO ₃ 5:1 2/	5/18	73	92.3	5/18	579	87.7
" " 7:1	5/18	148	91.2	5/18	460	81.9
" " 10:1	5/18	133	81.2	5/18	411	87.3
" " 20:1	5/18	57	82.6	5/18	337	82.2
Kerosene spray	5/12	101	73.3	5/12	357	52.9
Store oil spray	5/12	75	98.7	5/12	520	44.4
Store oil and burning	5/13&6/3	70	100.0	5/13&6/3	338	100.0
Diesel oil	6/3	154	98.0	6/3	360	82.8

1/ Concentration expressed as percentage by dry weight

2/ Parts Borate ore to parts sodium chlorate by dry weight applied as a dust; other chemicals were applied by spray form as aqueous solutions or full strength liquids.

Since the same treatments are being repeated every three months for the first year, relative cost data are not yet complete.

Utilization Standards. Upon the completion of the first year's empirical work devoted largely to the assembly and analysis of existing data and the issuance of tentative utilization standards, a detailed problem analysis, project work program, and work-

ing plan were prepared.

The working plan, which covers only the one section of the work program that ranks first in priority, provides for a study of the resistance to grazing of blue grama (Brachyelymus gracilis), mountain muhly (Muhlenbergia montana), and Arizona fescue (Festuca arizonica) by controlled artificial harvesting of the grass to different degrees and intensities on replicated and randomized plots. These species are the three principal indicator grasses on southwestern national forests, and one or more is the key utilization plant on two-thirds of the 18 million acres of usable grazing land within Forest boundaries.

Subject to final approval, the plan provides for a series of ten fenced installations to be located at various points throughout the Southwest and to be constructed and ready for use by June 1, 1939, when the first harvesting will occur. Treatments will continue for 5 years. There will be one master blue grama installation approximately 300 by 200 feet in which will be located 140 small plots -- each 2 by $2\frac{1}{2}$ feet with an 18-inch isolation strip -- to permit 4 replications of the 9 summer, 7 winter, and 6 yearlong treatments to be tested, and the check plots. The harvesting treatments will simulate various seasons and intensities of grazing. There will be 4 installations approximately 100 feet square in each of which will be a sufficient number of small plots to permit one replication of the 9 summer treatments. Likewise there is provision for 4 additional blue grama installations each accommodating one replication of each winter and yearlong treatment. For mountain muhly and Arizona fescue there will be one master installation 350 by 200 feet including 76 plots 2 by 5 feet in size with an 18-inch isolation strip to allow 4 replications of the treatments planned, all of which represent different kinds of summer grazing.

It is planned to locate the installations as follows: master blue grama on the Coronado National Forest for which sites are now being examined; the 4 summer blue grama on the Prescott, Kaibab, Coconino, and Apache or Kaibab National Forests; the 4 winter and yearlong blue grama on the Lincoln, Cibola, Tonto, and probably Apache National Forests; and the bunchgrass master on the Kaibab. During the present field season sites for the bunchgrass installation and 4 of the summer and 2 of the winter and yearlong blue grama installations have been selected. Construction has been completed on the bunchgrass and 3 of the summer blue grama areas.

Treatments will be mainly in the form of varied frequency and intensity of clipping ranging from one inch above the ground at monthly intervals to a very light clip only once during the grazing season. Harvested material will be air dried and weighed. Stand density and composition will be determined on all plots once annually about June 1 and twice annually for certain selected

treatments. The data obtained will show the effects of treatment in terms of forage yield, forage quality, plant vigor, stand density, and regeneration and site changes.

The work program provides for checking the results of the resistance to grazing clipping studies by actual livestock grazing in small pastures or panels. Studies in measuring utilization are given next priority to the resistance to grazing tests in the project work program. These will include development of measurements of utilization not only on key species but also over entire range units. Other phases of the work program include basic botanical and ecological studies as they relate to utilization, a consideration of management objectives on range units, and the ultimate development of utilization survey and inspection procedure.

Electric Fences. Preliminary results in the range use of one-wire electric fences on the Jornada indicate that such fences have possibilities as a cheap and effective means of controlling stock on the range.

In August 1938, $3\frac{1}{2}$ miles of one-wire fence were constructed around one of the large tobosa flats on the Jornada for the purpose of holding cattle on the tobosa summer feed and at the same time protect the surrounding grama grass from heavy use during the growing season. Following the heavy rains in July the tobosa grass was green and succulent and when the fence was built, the soil was very damp. However, before the electrical unit arrived, the soil had dried out thoroughly and the first results on this dry soil were disappointing. About 140 yearling heifers were placed inside the enclosure and at first they passed back and forth under the wire freely. After about 3 days a light shower fell wetting the ground to a depth of about one-half inch, and following this there was no more passing back and forth under or even approaching the charged wire. A trail in the moist sand inside showed that the animals never came closer than 4 feet of the wire and salt placed near the line was approached with extreme caution and from one side only.

The chief value of such an enclosure on ranges such as the Jornada seems to be that of holding cattle on summer feed especially where such areas are intermingled with and sometimes are entirely surrounded by range supporting grama grass which must be reserved for winter use. For this purpose these one-wire fences can be constructed quickly and cheaply and can be easily removed when no longer needed. Other uses suggested by the ease of construction or moving these fences are segregation of poison plant areas, holding non-breeding stock such as yearling heifers separate, for holding breeding cows and bulls together in an effort to increase the calf crop. The breeding period usually coincides with the summer season when it is desired to confine cat-

tle closely as possible on summer feed areas.

The cost of these fences is the most attractive feature of all. The $3\frac{1}{2}$ miles of fence constructed on the Jornada cost only \$33.70 per mile, which included supervision, labor, wire, posts, insulators, and the electrical unit with its battery. This is contrasted with the cost of a standard 4-wire fence which sometimes runs as high as \$200 per mile. The maintenance cost is very low, an ordinary 6 volt auto storage battery lasting 4 or 5 months before it is necessary to re-charge. The wire must be well insulated and patrolled frequently especially when first used, to repair any short circuits or grounds. The better control units have a device by which grounds can be detected as soon as they occur.

ARTIFICIAL RESEEDING

Intermountain

Great Basin. Indications from 160 experimental plots planted to 20 different species in the fall of 1936 and spring of 1937 are that the following may be reasonably relied upon in the higher altitudes of the spruce-fir zone:

Agropyron pauciflorum
Bromus carinatus
Bromus inermis
Dactylis glomerata

Arrhenatherum elatius
Phleum pratense
Agropyron cristatum

The seed germinated well and plants became established the first two years. How they will maintain themselves in a stand yet remains to be determined.

Of all the species tried Agropyron pauciflorum is the most aggressive on the poorer situations and in competing with the native vegetation. Bromus carinatus and Arrhenatherum elatius will mature and produce seed the second year. Other species occasionally produce seed heads the second year in the better situations, but they have not been observed to fill. All these species appear at this time to have a place in artificial reseeding programs in the higher elevations.

On 72 experimental plots planted to Bromus inermis and Agropyron pauciflorum in the fall of 1936, the commercial fertilizers ammonium sulphate and treble superphosphate were broadcast alone and in various combinations at the rate of 100 pounds and 200 pounds per acre. The purpose was to determine the effect of these fertilizers in getting seedlings started and established.

Present results indicate that for the soils involved, there are no apparent beneficial results from using these fertilizers. The first year after application a difference could be seen in the color and amount of growth of the native vegetation, but the difference was not great enough that it was readily apparent.

Davis County. The reseeding of range lands as a means of aiding in the revegetation of watersheds has proved very successful on the Wasatch Mountains of northern Utah at elevations of from 7,500 to 9,000 feet. The Davis County floods of 1923 and 1930 that destroyed property and lives, originated from denuded areas which amounted to only about 6 percent of the whole watershed. Beginning in 1933 these denuded areas, on which the water had accumulated, were terraced with contour trenches. In the fall of 1934 smooth bromegrass, slender wheatgrass, Kentucky bluegrass, meadow fescue, and Italian ryegrass were broadcast by hand upon all terraces that had been completed. As terracing progressed, the seeding has been continued every fall up to and including 1938.

Italian ryegrass and meadow fescue have on the whole done poorly; Kentucky bluegrass has established itself in a few places but does not seem to be vigorous. Smooth brome and slender wheatgrass have done well on practically all sites. On the more favorable sites the smooth brome exceeds slender wheatgrass and produces a maximum amount of forage, while on the sites having soils poorer in organic matter and lower in moisture-holding capacity, slender wheatgrass seems to have done better.

On most sites both of these two grasses are thriving. Not only have they covered the terrace trenches with a thick stand of grass which is from knee high on poorer sites to above waist high on better sites, but they are growing in the bottoms and on the sides of the old gullies left after the storms of 1923 and 1930. The gradual transition in stand from 1-year-old to 4-year-old seedlings is quite remarkable. The first year seedlings are very small and the casual observer might be led to conclude that the plantings had failed. Although the second year seedlings are still small they are rather vigorous and produce some seed stalks. The 3-year-old plants are large vigorous bunches which produce a good seed crop.

Four-year-old stands of slender wheatgrass contain tall vigorous bunches and many small seedlings, while 4-year-old stands of smooth brome have enlarged bunches and in some cases a solid sod over many square rods. The spread to adjacent unseeded areas seems to be rather rapid after the third year. Without doubt these grasses will spread still more and not only aid in controlling floods, but will form a sod which will endure and check erosion far beyond the age limit of contour terraces. It also seems likely that after a time they could withstand moderate grazing.

without injury to the watershed.

RANGE FORAGE

California

Foothill Ranges: Forage Inventories. Range forage was markedly different this year from that of the two previous seasons, as revealed from the inventory made through the six grazing-capacity pastures on the San Joaquin Experimental Range. In certain respects the 1938 crop was more like that of 1935. During the last year, as in 1935, all of the swales supported a good stand of clover (Trifolium), and one species (Trifolium microcephalum) was widely distributed over the ridges. In 1936 and 1937 there was little clover to be found any place. Cattle graze heavily on the clover species and do best on the range when these are abundant.

The belated rains of last fall were unfavorable to the germination of some of the early maturing species such as broadleaf filaree (Erodium botrys) and soft chess (Bromus mollis); as a result, competition was reduced for some of the later growing plants and the vegetation turned out to be more "weedy". There was a marked increase in all of the Lotus species, in Lupinus bicolor, Trifolium spp., Hemizonia virgata, and Gedelia spp.

The proportion of introduced species in the forage this year fell to 44.3 percent. This compares with 44.8 percent in 1935, 72.3 percent in 1936, and 81.9 in 1937. For the four years the introduced species averaged 60.8 percent and the natives only 39.2 percent. A recent analysis of the forage data shows that broadleaf filaree and soft chess are by far the most common of the introduced species; these alone made up 83.2 percent of the introduced fraction. The high percentage of the introduced species in the composition indicates that some of them are better adapted to California range conditions than are the natives, or they would not have replaced them to such a large extent.

Pacific Northwest

Distribution of Forage Weight in Green Fescue Plants. Several of the stations have recently been studying the weight distribution of forage produced in certain grass species and have found in general that considerably more weight is produced in the lower part of the plant than in the upper part. Also, there appears to

be a similarity in weight distribution of forage between grass species. Uniformity of results from initial clipping studies has led to the hope that percentage utilization of a key grass species may be estimated by measuring the residual stubble height after grazing. Residual stubble heights of a particular grass species, however, are a valid indication of percentage forage removal only if the growth form of the plants remains fairly constant from year to year and between different localities. Data from two years of clipping studies at the Pacific Northwest Station give some interesting information on this subject.

In 1937, 506 plants of green fescue (Festuca viridula) were clipped at 5-centimeter intervals starting 1 inch above the root crown in order to arrive at the proportional amount of forage in each 5-centimeter "layer." The study area was located in the Cascade Mountains on the Wenatchee Forest, on lightly grazed cattle range, and clipping was done at the end of a rather poor growing year. The proportion of forage in each 5-centimeter height interval is listed in column 2 of the accompanying table.

In 1938, 187 green fescue plants were clipped similarly on the Wallowa Forest in northeastern Oregon on heavily used sheep range at the end of a favorable growing season. Results of the 1938 clipping study are listed in column 3 below.

Similarity of growth form of this grass species, considering that the clipping was done on widely separated areas in different years, is striking and would indicate that the proportion of forage produced at specified heights is a fairly constant value for this particular grass.

<u>Height Interval</u>	<u>Percent of Forage Produced</u>		
	<u>1937</u>	<u>1938</u>	<u>Difference</u>
0-5.0 cm.	45.2	47.1	+1.9
5.1-10.0 cm.	29.5	28.6	-.9
10.1-15.0 cm.	15.9	15.9	0
15.1-20.0 cm.	6.5	6.5	0
20.1-25.0 cm.	2.2	1.5	-.7
25.1-30.0 cm.	.6	.3	-.3
30.1-35.0 cm.	.1	.1	0

Plans for New Range Research Project. The Division of Range Research has spent the past two years in general studies such as the Western Range Survey and the development of more accurate methods of measuring forage utilization and forage production. While these phases have not been carried to completion, it is thought advisable to concentrate the work on specific problems of range improvement so that results of the studies will have im-

mediate application in the administration of grazing on the national forests. In view of the limited appropriation for range studies and after consultation with members of the Regional Office and with the Chiefs of the Divisions of Range Management and Range Research, it has been decided to limit the work at present to the problem of how to improve forage conditions on mountain meadows within cattle ranges and still get reasonably full use of the forage on surrounding timbered range. Selection of a suitable cattle allotment on which to begin work will be made this fall if possible and plans for carrying on the study will be prepared in cooperation with the Division of Wildlife and Range Management.

Rocky Mountain

Orange sneezeweed investigation. The abundance, growth habits and general ecological relationships of orange sneezeweed (Helienum hoopesii) were studied in detail on 37 sites on the Grand Mesa, Uncompahgre, and White River National Forests during the 1938 field season. A transect of 10 equally spaced 100 square-foot plots was the unit of study for each site. Particular attention was given to the external nature of the habitat; the abundance, growth habits, and phenology of sneezeweed; the plants associated with sneezeweed; and the condition and grazing history of the range.

From a preliminary examination of the field data, the following conditions are indicated:

1. Sneezeweed occurs most abundantly on rather deep loamy soils of dry meadows and open aspen types at elevations from 8,500 to 10,500 feet. Other conditions often associated with heavy stands of sneezeweed are: past overgrazing, weedy vegetation types, well-drained areas at high elevations or moist areas at lower elevations (not observed in wet meadows) and areas with a heavy infestation of pocket gophers. The stand of sneezeweed under "favorable" conditions often exceeds 30 percent of the plant cover.

2. The lower limits of sneezeweed growth seem to be in the Artemisia tridentata types, but the plants grow abundantly in Artemisia cana types. No upper growth limit was established, but sneezeweed is known to occur above timber line.

3. Some sheep have a high degree of preference for sneezeweed and may graze 50 percent of the plant. The animals crop the heads first, then the stem (flower stalk) leaves and basal leaves. Sheep often graze sneezeweed in preference to such plants as Geranium richardsonii, Achillea lanulosa, Lathyrus spp. and other plants usually rated high for sheep.

4. Losses from sneezeweed are perhaps greater than is rea-

lized. Several bands of sheep examined in August had 10 to 12 sick animals and the herders reported several deaths. Several herders were moving their bands from allotments before the grazing season was one-half spent. One band has been forced to leave the national forest allotment for the past five years after having grazed for only 4 to 6 weeks of the three months allotted.

5. No definite losses of cattle from eating sneezeweed were reported and very little evidence of cattle having grazed sneezeweed was found.

6. Several enemies of sneezeweed were found. At least two kinds of larvae infest the heads of the plant, and feed within the seed. A different kind of larva inhabits the roots of sneezeweed. A rust was found on the leaves of many plants. The extent of damage caused by these infestations is being studied further.

7. Sneezeweed reproduces by seeds and root crown offsets. Offset buds are produced in late August or September on the root crowns of plants that have flowered the current season. By the last of September these buds have formed new plants ranging from one to six inches high. The production of buds continues throughout September and probably into October so that the new plants are variable in size. Practically every plant that flowered during the current season had some new offsets; the average number was 6.0 per plant. Very few buds or new plants were produced by plants that did not flower this season.

The observations and studies of the past season will form the basis of a plan of work for further investigations.

FOREST PRODUCTS

TIMBER HARVESTING AND CONVERSION

California

"High-risk" Trees on the Blacks Mountain Experimental Forest. Valuation of standing trees by the log-grading system on four Experimental Forest sample plots indicates a slightly lower lumber conversion value per M B.M. for the "high-risk" trees than for the average tree cut by the regular Forest Service system of marking in the same ponderosa pine type. The high-risk trees, i.e., the trees designated by entomologists as those most likely to succumb to insect infestation within the next 1 to 5 years, averaged

2.6 trees an acre, whereas Forest Service marking would remove 11.1 trees an acre. The volume of the average high-risk tree was 1,253 feet b.m. as compared with 1,492 feet b.m. for the average tree marked under the Forest Service rules. The average rough-dry lumber selling values, based on 1935-36-37 average selling prices, were as follows:

High-risk trees - - - - -	\$24.08 per M B.M.
Forest Service marking -	24.22 " "

The small difference of 14 cents per M can hardly be considered as an implication that the bugs have a taste for lower quality trees. Within any particular diameter class, they take the good along with the poor but the average volume of the trees they select, which was about half way between the average for the entire stand and the average of the Forest Service marking on these sample plots, reflects their habit of concentrating their attacks within the medium size range.

Northern Rocky Mountain

Logging and Milling Studies. The bulletin "Results and Application of a Logging and Milling Study in the Western White Pine Type of Northern Idaho," published under the joint auspices of the Western Pine Association, State Forester of Idaho, and School of Forestry, University of Idaho, has been received from the printer and 1,700 copies have been distributed to forest schools, lumber companies, and individuals, with a reserve of 300 copies retained at Missoula.

A map and cruise of the 600-acre Haynes Creek drainage on the Deception Creek Experimental Forest was made this summer. This area will be a demonstration area designed to show how the best logging methods compatible with good silviculture can be applied. The first logging will be done in 1939.

Pacific Northwest

Mill Production Studies. The project was expanded this year to include sawing time studies in mills other than those in which grade-recovery studies are made. Six such studies were made, the mills being chosen because of differences in capacity or in equipment. Two out of the six were made at the request of the managers because they could see the advantages in such an analysis of their own operations. The time studies were designed with two objectives in view: (1) To obtain a record of sawing time, from which costs for logs of different sizes can be determined, in mills of different capacities, and (2) to so break down the components of

sawing time that relative efficiencies of equipment on logs of different sizes could be established. To date reports summarizing the findings of each study have been prepared and sent to the cooperating mills.

The following summary, presents in a general way the relative efficiencies of the mills analyzed, but only in so far as actual sawing time is concerned. Other factors, such as man-hour output, overhead, investment, and repairs, must be considered before conclusions can be drawn.

Mill	Type of Headrig	Weighted average sawing time per M feet green tally	Sawing time per line in 20-inch 16-foot logs
		(Minutes)	(Minutes)
C.L	8-foot double-cut band	5.67	.076
U	8-foot band	7.13	.100
B-B	8-foot band	7.38	.105
DeA	7-foot band	7.88	.127
V	Circular-steam feed	9.58	.184
C	Circular-friction feed	11.47	.190

Part 1 of the report on the Shevlin-Hixon study conducted in September 1937 was prepared and sent to the company. This one showed the effect of using a gang saw on small logs. In band mills where gangs are not used the milling cost (per M feet of lumber recovered) for small logs (10 inches) is usually nearly twice that for large logs (36-40 inches). Where the gang is used, however, the cost for small logs is almost identical with that for large logs.

FOREST PRODUCTS STATISTICS

Northern Rocky Mountain

Lumber Census. In June, a preliminary statement summarizing the results of the 1937 Idaho-Montana lumber and timber products census was prepared and released in the form of an Applied Forestry Note. The total 1937 lumber cut in these two States amounted to 1,131,901 M feet, an increase of 11.1 percent over the

1936 cut. The Montana output of 334,950 M feet by 144 mills was the largest cut recorded for the State since 1929. In Idaho a cut of 796,951 M feet by 204 mills was larger than that of any other year since 1930.

Approximately 75 percent of the aggregate lumber cut of Idaho and Montana in 1937 by mills cutting 50 M feet and upward was contributed by Idaho white pine and ponderosa pine. For each year since 1929 these two species have contributed from 71 to 78 percent of the total volume of all species reported. In 1931, and again in 1933, Idaho white pine alone contributed about 51 percent of the total output for the two states. The 1937 cut of this species in Idaho, amounting to 459,531 M feet, was the largest annual cut of white pine ever reported for the State. The second highest cut of white pine was reported for 1936 with a total output of 441,848 M feet.

In addition to the preliminary statement referred to, the tables and chart included in a publication, "Lumber Production in the Northern Rocky Mountain Region Since 1869," issued by this Station a year ago, have been revised by including records for the year 1937. Multilithed tables containing data on production, wage earners, and other information for northern Idaho, southern Idaho, northeastern Washington, and Montana, have also been prepared for use at the Station.

Depletion by Cutting. Census tabulations, supplemented by origin-of-logs data obtained from sawmill operators logging in one county and milling in another, and those receiving logs from two or more counties involving, in a number of cases, interstate log shipments, were used as a basis for sawlog production tables for the year 1937, recently compiled. In addition to the sawlog depletion tables presented in Forest Survey Release No. 1, covering the 10-year period 1925 to 1934, inclusive, comparable data for each of the years 1935, 1936, and 1937 are now available.

Because of interstate log shipments, the lumber tally depletion figures corresponding to sawlog volumes (lumber tally basis) cut in any specified subdivision of Region One differ materially from the lumber-cut figures based on the sawmill operators' lumber production for the same area. Such differences are particularly apparent for northeastern Washington and northern Idaho, and can be quite clearly illustrated by means of the figures for northeastern Washington presented below:

In 1937 the total lumber cut reported by all active mills located in Spokane, Pend Oreille, and Stevens Counties, Washington, amounted to 225,016 M feet. Of this amount 148,673 M feet of lumber was produced from timber grown in these counties and 76,343 M feet from timber grown in other localities, with sources distribu-

ted as follows:

	<u>M Board Feet</u>	<u>Lumber Tally</u>
1. Logs imported from northern Idaho	72,985	
2. " " " Canada	2,466	
3. " " " Western Montana	892	

In the same year total sawlog production for northeastern Washington (Spokane, Pend Oreille, and Stevens Counties combined) amounted to 162,195 M feet lumber tally. Of this amount 148,673 M was manufactured into lumber by mills operating in northeastern Washington and 13,522 M by mills operating in northern Idaho.

Total sawlog production for Region One, as a whole, in 1937 amounted to 1,188,801 M lumber tally as against a total lumber cut of 1,190,267 M, which included 2,466 M feet of lumber tally of logs imported from Canada. One million feet of logs produced in Region One were milled in Region Four.

Pacific Northwest

Statistics, Lumber Census. The 1937 lumber census was completed the latter part of June. For the first time contract loggers were included in the canvass, adding considerably to the work involved. Schedules were sent to about 3,000 concerns. Approved schedules of 2,295 operators were sent to Washington. Preliminary compilations show that lumber production in Oregon and Washington in 1937 amounted to 9,063,563 M feet, board measure, an increase of approximately 4.8 percent above the 1936 production. Washington production amounted to 4,712,838 M and Oregon to 4,350,725 M. The total cut of Douglas fir was 6,213,974 M, an increase of about 3.8 percent. The ponderosa pine cut was 1,805,713 M, an increase of 13.2 percent. Lath production in 1937 amounted to 354,728 thousand pieces, and shingle production to 5,169,745 squares.

WOOD PRESERVATION

Pacific Northwest

Arsenic Preservative. Seven hundred of the 1,100 arsenic paste treated poles now in telephone lines in various parts of the region were inspected during the present field season. It was found that 13 additional poles, making a total of 19 out of the 700, had developed rot at ground line and that one of those which showed rot last year had deteriorated so badly that it will soon be necessary to replace it. The defective poles had been set and treated during 1933 and 1934. Arrangements were made for 350 new poles, which will be tagged and data recorded in 1939. Half of these have been set untreated in order to provide check poles, a requirement it had previously been impossible to fulfill.

Southwestern

Longevity of Juniper and Cypress Fence Posts. A study was initiated in the fall of 1937 to determine the relative durability of four native junipers and smooth cypress. Forty-five posts each of Utah, one-seed, Rocky Mountain, and alligator juniper, and 180 posts of smooth cypress were cut, peeled, and air seasoned. The cypress posts were then divided into four lots. Three of these were given preservative treatments at the Forest Products Laboratory and the fourth was retained for a check. The treatments used, which could be duplicated in the Southwest, are:

1. Full-length treatment hot and cold coal-tar creosote.
2. Butt treatment hot and cold coal-tar creosote.
3. Butt treatment of tetrachlorophenol.

All the posts have been measured for the width of the heartwood and sapwood and the area of wood exposed by checking will be determined for each post just before it is placed in the ground. Three sets of 120 posts each will be tested under three types of decay hazard, in the dry-desert land where the hazard is low, in wet-irrigated land where the hazard is high, and in the humid-plateau land where the hazard is intermediate. The humid-plateau installations have recently been completed and the remainder of the test fences will be installed during the fall and winter.

WOOD STRUCTURE AND GROWTH

Pacific Northwest

Cooperation. Samples of white pine (*Pinus monticola*) were collected on the Rogue River National Forest and forwarded to the Madison Forest Products Laboratory for specific gravity tests. The Rogue River has a considerable stand of this species which is overmature and for which a market has recently been opened up. The logs are hauled to the sawmill at Central Point, Oregon. The lumber is then shipped to Spokane, Washington, where it is placed on the market mixed with the white pine cut in Idaho. If the Laboratory tests indicate quality equal to that of the Idaho grown timber, the Forest Service will be able to charge a higher stumpage rate than would otherwise be the case.

FOREST SURVEY

Appalachian

Inventory. Four 3-man crews were organized in June to extend the inventory field work to the mountain unit of North Carolina. Despite difficult topographic and brush conditions, the crews have made good progress and by October 1 approximately three-fourths of this $5\frac{1}{2}$ -million-acre unit had been covered. The completion of the work in this unit will finish the inventory field work for the entire state of North Carolina.

Depletion. The mill-to-mill canvass of the wood-using industries in North Carolina was continued through the summer. A preliminary analysis of the data indicates that the number of mills and the total cut for the state will be much larger than anticipated. Although only 66 of the 100 counties in the state have been covered, more than 2000 sawmills, operating in 1937 and cutting over 1 billion board feet of timber, have been reported.

Office. The compilation work and the preparation of reports have been greatly facilitated by the transfer of T. C. Evans and E. B. Faulks to this Station from the Survey's staff of the Southern Forest Experiment Station, effective July 1.

A considerable portion of the time of the Survey staff during July and August was spent in compiling data and preparing tables for the Joint Congressional Committee Report. To make up

totals for the South Region, forest area and timber volume figures were computed by this Station for South Carolina, North Carolina, Virginia, West Virginia, Tennessee, and Kentucky, and combined with those compiled by the Southern Station for the other southern states.

Pacific Northwest

Douglas Fir Region: Reports. The regional report was revised, completely retyped, and returned to Washington for further review during the summer. County statistics for Clatsop County, Oreg., and Grays Harbor County, Wash., were brought up-to-date, revised, mimeographed, and distributed.

Inventory Revision. Field work on the inventory revision of Pierce and Pacific Counties, Wash., and Columbia and Coos Counties, Oreg., was completed during the summer. No further field work will be undertaken this calendar year.

Ponderosa Pine Region: Inventory Results.

Summary of Cubic-Foot Volumes for the East Side of Region 6

	Ponderosa pine	Species other than ponderosa pine	All species
	Million cu. ft.	Million cu. ft.	Million cu. ft.
Eastern Oregon	12,730	7,578	20,308
Eastern Washington ^{1/}	3,240	7,208	10,448
Total	15,970	14,786	30,756

1/ Exclusive of Stevens, Spokane, and Pend Oreille Counties, which are in Region 1.

Growth Phase. Computation of future growth and estimation of future volume inventories 10, 20, and 30 years hence that would result from various assumptions made as a part of the depletion phase of the forest survey have been completed for the east side of Region 6 during the past four months.

Yield table adjustment factors designed to allow for approach of understocked stands to normal have been applied to the growth estimates made for all areas of even-aged, immature ponderosa pine types. These factors were based on the findings of J. W. Girard and L. J. Cummings in Region 1. Application of these factors resulted in an increase of 30 percent in the estimated growth for the types to which they were applied, but owing to the limited extent of such

types in this region the estimated growth for the entire region was thereby increased less than 4 percent.

Southern

General. Eldredge attended a conference at the Regional Office in Atlanta September 9.

Ineson spent the entire month in Washington working on naval stores analyses and the report for the Joint Congressional Committee.

Winters left New Orleans September 24 for Washington to discuss with Garver and Census officials the possibility of mutual cooperation between the Survey in the South and the Census Bureau in compilation of industrial production of timber products in Southern Survey territory. A cooperative arrangement between the Southern Forest Survey and the Census Bureau has been a long-felt need and Winters' conferences are expected to make such cooperation a reality.

Naval Stores Region: Interpretive Section. A release, "Forest Resources of Southwest Alabama," by Spillers, was multi-lithed and mailed to the Survey mailing list.

Mississippi Delta. Advance copies of a unit report entitled "Forest Resources of the North-Louisiana Delta," by Eldredge, Winters, and Putnam, were received from Washington. This unit report is published by the Government Printing Office as U.S.D.A. Miscellaneous Publication No. 309. The report is the first of the Southern Survey's unit reports to be issued by the G.P.O.

FOREST ECONOMICS

NEW PUBLIC DOMAIN

California

Land Utilization: Second Growth. A most pressing problem of our land-use studies is the utilization of the second-growth ponderosa pine stands of the Sierra Nevada foothills. Many of these stands, which came in during the early mining period about 70 years ago, contain numerous trees above 24 inches d.b.h., with some individual trees attaining a d.b.h. of 36 inches and a height

of 150 feet.

To the small portable sawmills which have cut small amounts of second growth for local use for a number of years, and the production of lumber for remanufacture into box shook which has more recently gained in importance, has now been added the cutting of the more rapidly grown second-growth ponderosa pine trees for veneer bolts. Trees having long clear internodes are necessary for this purpose. On one operation in El Dorado County, such trees from 18 to 35 inches in diameter are felled, then bucked with a power drag saw into clear bolts from 15 to 28 inches long, leaving the knot whorls in sections of 8 or more inches in length. Part of the knotty sections are utilized for fuelwood. Veneer bolts account for about 55 percent of the cubic volume of the trees, and the knotty sections for 33 percent.

The stumpage price for veneer bolt trees is \$2.00 per M B.M., Spaulding rule. Bolts are trucked 70 miles to Sacramento and sell for \$19.00 per M B.M. Rotary cut veneer $1/12$ inch in thickness is then cut from the green bolts, is trimmed and seasoned, then stapled into sections for use as tops of various types of fruit boxes.

The rapidly increasing and too largely destructive utilization of second-growth stands is arousing in foresters a concern for the future of these stands, and all hands are turning to the problem of bettering both utilization and management.

Climate. An attempt to make climatic records a major basis of land classification is beset by difficulties of large proportions in a region of sharp topographic relief like that of the northern Sierra Nevada foothills. The major belts of crop and vegetation growth are clearly altitudinal and climatic. But in detail, anomalous variations are frequent within short intervals of both space and time. The two weather stations of Nevada City and Grass Valley, for example, are only 4 miles apart and at an elevation only 100 feet different. Yet Grass Valley, which is the higher of the two, has a frost-free summer period of 208 days, which is 69 days longer than the 139-day period of Nevada City. Differences of aspect, exposure, etc., may bring such changes within the space of a mile.

Weather stations are so few, and microclimatological data so lacking that it is quite impossible to build up any existing record capable of indicating such variations. The same applies to the agricultural workers' favorite measure of available heat, which must be calculated from existing weather data.

Pacific Northwest

Management of Tax Delinquent Lands. The following indicate some of the directions in which the New Public Domain studies are progressing in the Douglas fir region.

On invitation of J. G. Boyington, Judge of the County Court of Clatsop County, Oregon, Wilson met with the court in the court rooms and in the field where he reviewed problems affecting the management of some 80,000 acres of forest lands tax-forfeited and now owned by the county. The court has completed an inventory of all county lands, each property being listed on a separate card containing the legal description, character, cost, and estimated value of the property. The court has also employed an officer to assist in managing these lands. Judge Boyington deplored the adverse effects of destructive logging upon employment and social welfare in general, challenged the right of owners to continue devastating practices, is interested in the legal steps necessary to stop it, and appears to favor in general the permanent public ownership of tax-forfeited lands preferably as county forests. The county court, being pressed to sell timber stands on county lands, desires to sell timber only under contracts requiring proper silvicultural practices; opportunities for cooperation from the Regional Office and Research were briefly discussed and may be followed up by the court. A program of seeding and temporarily grazing large areas of cut-over county lands is being considered as a means of raising revenue during the period required to reestablish a forest cover; deferment of action on the program was suggested until research in grazing Douglas fir lands had progressed sufficiently to determine the feasibility of this interim use.

On invitation of President Peavy of Oregon State College, Munger and Wilson met with Mason of the School of Forestry and H. Kyle, State Fire Warden, and examined the school's forest property of about 2,400 acres and adjacent cut-over lands, comprising approximately 14,000 acres, all within the Fishhawk Creek drainage in Columbia and Clatsop Counties. The purpose of the visit was to see in a preliminary way what disposition should be made of the school property. The lands within the drainage are typical of forest areas in many parts of the Douglas fir region. Nearly all of the drainage is clear cut and the few remaining stands of saw timber will be removed probably by the end of 1938. Much of it, including the school property, has been burned and reburned. Fire hazards are increasing and restocking to conifers runs from poor to zero. Before logging the lands were all privately owned; after logging the 2,400-acre tract was presented to the school of forestry and the major portion of the balance has been forfeited for unpaid taxes to the counties and is unmanaged. It was the consensus that even before extensive management of the school

tract would be justified the major part of the entire drainage should be placed in stable public ownership and fire-proofing should be undertaken. A series of conferences with State and county officials is planned by Research and State and Private Forestry in an attempt to solve this problem, which if solved may establish a sound procedure for establishment of State or county forests in Oregon.

Land Classification. In continuation of his cooperation with the Bureau of Agricultural Economics in land classification, Wilson was called upon by the BAE to review land classification reports for Clark County, Washington, and Boundary and Latah Counties, Idaho. These reports show commendable progress in the treatment of land classification in the Pacific Northwest but may be improved in certain important particulars. For example, lands are described frequently as being too steep or not too steep for arable agriculture, but no topographic data are included and no reference is made to how steep "steep" is. Again, the measure of an economic farm unit is usually reduced to the single factor of what is the minimum acreage of crop lands needed to comfortably support a farm family, without recognition of the influences of extensive farming including woodland management upon the economy of the farm as a whole. Moreover, there is still a tendency to recommend long-term use patterns for lands within tension zones, usually on the basis of present, admittedly unstable economic conditions; short-term programs would appear more desirable for such areas. As to taxation, the problem of adapting local government to the natural land use pattern as modified by planes of living is still not fully understood; so far emphasis has been placed upon adapting land use and ownership to existing services supported at public expense.

Taxation. Local government reorganization studies were continued in Tillamook and in Klamath Counties, Oregon. The possibility of consolidating the 34 elementary school districts and three high school districts of Tillamook County into three union school districts was explored, with special reference to its effect on forest land and timber taxes. In this county the tax base per pupil varies from \$2,724 to \$25,659 and the total tax rates on timber property for school purposes vary from 12.6 mills to 46.3 mills.

The average amount of the property tax on timber property per acre and per thousand board feet was computed for the even years for the three Oregon counties where timber tax base depletion has been the greatest over the past 10-year period.

<u>Clatsop</u>	<u>1926</u>	<u>1928</u>	<u>1930</u>	<u>1932</u>	<u>1934</u>	<u>1936</u>
Tax per acre	\$2.48	\$2.67	\$2.27	\$1.90	\$1.44	\$1.38
Tax per M ft. b.m.	.051	.054	.046	.039	.029	.028

Columbia

Tax per acre	2.95	2.93	2.74	1.98	2.02	1.99
Tax " M ft. b.m.	.067	.066	.062	.045	.046	.045

Tillamook

Tax per acre	1.68	1.74	1.60	1.35	1.03	1.03
Tax "M ft. b.m.	.034	.035	.032	.027	.021	.021

Source - Biennial Report of the State Tax Commission and the Forest Survey.

These data apply to the private timber stand of the county as a whole as it existed at the assessment date for the year indicated. It should be remembered that the composition and quality of the timber stand for the county as a whole is altered as depletion progresses. The data only serve to indicate the absolute burden of the property tax. The relinquishment of some county functions to the State, together with strict economy, has made a lower average property tax possible in spite of liquidation.

Private lands now subject to the yield tax or reforestation law in the Oregon counties of Tillamook, Clackamas, and Klamath were located on the detailed forest survey cover maps to observe what type of forest property was subject to the specific tax provisions of this law. In considering the results of this study which is shown below, it should be remembered that the survey maps of Tillamook County are as of September 1933, of Clackamas County as of March 1933, and of Klamath County as of November 1934, whereas the reforestation lists are as of the spring of 1938.

<u>Forest Type</u>	<u>Tillanock</u> <u>Acres</u>	<u>Clackamas</u> <u>Acres</u>	<u>Klarath</u> <u>Acres</u>
Nonforest	200	120	5,540
Pine woodland (desert fringe)	--	--	2,440
Coniferous saw timber	1/3,520	1/6,160	2/16,060
Coniferous second growth-small	3/3,900	3/15,020	---
Restocked cutover	400	--	32,940
Recent cutovers	11,160	7,340	17,760
Old cutovers poorly or nonrestocked	440	--	22,300
Deforested burns	19,280	4,080	2,080
Noncommercial	--	--	1,400
Total	38,900	32,720	100,520

1/ Generally more than 20 inches d.b.h.

2/ Generally more than 12 inches d.b.h.

3/ Generally less than 20 inches d.b.h.

Southern

Tax Delinquency. Preliminary analysis of the data on the extent of, and trends in, tax delinquency in three eastern Oklahoma counties was completed by Craig. The extent of delinquency is shown in table 1. The relationship among these three counties in extent of delinquency is most accurately shown by the data in the last two columns - "Total area involved in delinquency."

The extent of "area in county title in fee" is dependent on the frequency and date of resales in each county, as is also the relation between these areas and those eligible for resale. In Latimer County, for example, the last resale was held in May, 1936, and all land then eligible for resale was disposed of, either to the county or to private purchasers. Hence in May 1938 there was no land eligible for resale in Latimer County. In Adair County, on the other hand, no resale has been held since a courthouse fire in 1929 destroyed tax records, but a large area is now eligible for resale, being that bid in by the county at the 1935 tax sale. In Creek County, the 5,576 acres in county title in fee were derived from lands bought by the county at the resales of 1930 (last one held), 1928, and 1927. In addition, the county holds tax liens on nearly 160,000 acres bid in by the county at a tax sale held in November 1936. These lands are not eligible for resale, however, until May, 1939. The high degree of delinquency - from 13.4 to 26.8 percent

of the respective gross areas of these counties - arises from different causes. In Latimer and Adair, it is presumably largely the result of overcutting of the timber - an important item in the tax base - leaving large areas of deteriorated forest on which payment of even low taxes was a burden. In Creek County, it is the result of excessive speculation in oil and gas lands, wild issuance of bonds on "watered" values, and the resulting extremely high taxes for debt service, on values now badly deflated by the bursting of the oil bubble.

These counties contain large areas of other non-taxable lands, chiefly Indian allotments exempt under the treaty between the United States and the Five Civilized Tribes (Cherokees, Choctaws, Chickasaws, Creeks, and Seminoles). Latimer County also has several thousand acres of unappropriated federal public domain, and all counties have some State-owned lands and other constitutionally exempt properties. It is estimated that the percentage of gross area now off the tax roll for all causes, including delinquency, in these counties is as follows: Latimer, 23 percent; Adair, 36 percent, Creek, 33 percent.

The analysis of trends in delinquency indicates that in Latimer and Adair Counties most of the area now involved was derived from delinquencies prior to the depression starting in 1930. In Creek County, however, about 76 percent of the present delinquent area has been derived from tax defaults since 1929. In all counties the general trend since 1930-1931 is downward, although Creek County showed an increase in 1935 over the three preceding years, but not up to the 1930 peak.

More critical analyses and further amplification of these data will be made in the formal report on this study.

One striking feature of this study is the complete latitude allowed county officials in the methodology of taxation collection through what is defined in the statutes as "distraint and sale of the property assessed." Among the eight counties so far covered in this study, the methods and frequency of "annual" tax sales and resales, record-keeping, and legal interpretation of the statutes vary as widely as though each county were a separate and sovereign nation. Apparently in matters of taxation and tax delinquency procedure they are almost sovereign. This situation, among others, indicates strongly the need for the present recodification and revision of the whole body of statute law of Oklahoma now being carried out by a committee of the State Bar Association.

In respect to relative degree of tax delinquency which has reached the point where the property is eligible for re-

Table 1. Extent of tax delinquency - 1938

Eastern Oklahoma Counties

County	Gross land area (acres)	Area in county title in fee <u>1/</u>		Area eligible for resale <u>2/</u>		Total area involved in delinquency	Percent of total delinquent area which is forest land (estimated)
		Acres	Percent of gross area	Acres	Percent of gross area		
Latimer	470,400	63,030	13.4	0	0.0	63,030	13.4
Adair	373,760	0	0.0	100,149	26.8	100,149	26.8
Creek	616,360	5,576	0.9	<u>3/</u> 159,600	25.9	165,176	26.8
					<u>4/</u>		35

1/ Land owned by county in fee through purchase of tax certificates at resale.
2/ Land on which county holds tax lien on full interest, the same being subject to resale.
3/ Technically not subject to resale until May 1939.
4/ Excluding 7,256 acres, delinquent in fact, but on which no tax certificates are outstanding owing to error in notice of sale.

sale - or has already been forfeited to county title - western Oklahoma, as represented by Beaver, Tillman, and Jackson Counties, is in much sounder condition than eastern Oklahoma, as represented by Latimer, Adair, and Creek Counties. Preliminary analysis, however, indicates that south-central Oklahoma, as represented by Carter and Love Counties, has the greatest degree of chronic tax default. Final data are not available on any of these western or south-central counties.

PRIVATE FORESTRY

Central States

Farm Woods. Late in June Field Assistants Johnson and Hall completed the field work on the farm woodlands of Richfield Township, Henry County, Ohio. The townships previously examined were Eagle Township in Hancock County and Washington Township in Auglaize County. Each of these townships was chosen for the investigation as representative of farming areas having a small, average, and large percentage of land in farm woodlands. In the order of mention the townships rank from low to high in percentage of farm-woodland area. According to the 1935 U. S. Census of Agriculture, Richfield Township had about 4 percent of its farm area in woodland while Eagle and Washington Townships had 11 and 17 percent respectively.

The office compilation of the field records was begun upon completion of the outdoor work. This work was interrupted in mid-August when Johnson's services were loaned to Forest Soils until October 1.

Lake States

A Farm-Woodland Survey. A study to determine the relationship of the farm woods to the farm enterprise as a whole is now in progress in Carver County, a typical agricultural county in southern Minnesota.

A technique has been developed for obtaining much of the necessary physical data from aerial maps prepared for the Agricultural Adjustment Administration. To supplement the map data, intensive cruises are being made in sample woodlands. Owners of these woodlands are interviewed to learn about wood production and consumption, pasture requirements, and other pertinent data. A survey of markets and prices in the county and in the Twin

Cities is also being made. It is hoped that on the basis of the studies being made in the woodlands, cruising and management recommendations applicable to farmwoods in the southern Lake States can be drawn up.

A Forestry-Farming Program for the Low-Income Area. The Station in cooperation with the Minnesota Division of Forestry has prepared a report of the study made last spring in the Littlefork area southwest of International Falls, Minnesota.

The Littlefork study area was chosen to include a typical part-time farming community with a tributary area of forested land. There are 240 farms located in the 10 townships studied, concentrated mostly in the eastern part. The State of Minnesota owns about one-half the land, the western portion of which still supports much merchantable timber.

The typical farm family in the area earns approximately \$400 cash in a year with nearly four families out of ten having an unsatisfactory standard of living. The management of the State forests for the benefit of the local inhabitants will provide some 16,000 man-days of annual employment on a permanent basis. This is enough to give winter work to all the residents who need and want it, and to provide a satisfactory standard of living for more than nine-tenths of the population.

Pacific Northwest

Selective Timber Management in Ponderosa Pine. Office work on the so-called Rock Top Unit cooperative study was carried on throughout the summer months and is now practically complete. This is a major case study of selective timber management in which this Station is cooperating with the Southwestern Station and Region 3 and with the consulting firm of Mason and Bruce. The computing work for this project has been carried on largely with ERA help, with some of the supervisory work financed by the Southwestern Station.

The technique and procedure followed on this project have been similar to those developed in previous case studies in eastern Oregon but ran into more ramifications owing to the defective character of the timber and to certain other peculiarities incident to the different type of timber and to differences in operating practices, etc. Despite these differences the major conclusions are much the same as in previous case studies in that they point to lighter cutting as a means to greater immediate returns and to greater future production both in quantity and quality.

Selective Timber Management in Douglas Fir. Important progress in selective timber management, particularly in the mechanics

of selection, has been made this summer on the operations of the West Fork Logging Company at Mineral, Washington. During the present year this operation has been conducted on a tree selection basis, including even the steep and rugged slopes of the Mineral Creek canyon. On the easiest shows logging is done with ordinary tractor-arch units but on more difficult ground this is supplemented or replaced by various combinations of sky-line swinging and cable yarding with tractor mounted double drum units; and in some cases ordinary donkey equipment is used except that a special low lead or nearly a ground lead is used instead of the more destructive high-lead. But, regardless of the equipment and methods used, the principle in logging is always the same, namely, to remove the few high-value, large Douglas fir and leave intact the hemlock, silver fir, and smaller trees of all species. As an engineering feat, employing modern methods of stand analysis and logging, the West Fork Logging Company has done a good job, left a forest cover behind, and profited thereby. Throughout the summer there has been a steady stream of visitors to Mineral, among others several western congressmen and senators, Secretary of the Interior Ickes and Mr. John Boettiger, editor of the Seattle Post Intelligencer, Chief Forester Silcox, and Assistant Chief Forester Tinker. All have expressed surprise at seeing individual tree selection so successfully practiced in this type of timber and on ground as steep and rugged as in this case.

The Station's and the Forest Service's part in these logging demonstrations is twofold. First, the basic principles, as well as some of the mechanics of logging here employed, were worked out in the course of the logging economics studies conducted by this Station during the years 1931 to 1936, the results of which were published in a bulletin by Brandstrom entitled "Analysis of Logging Costs and Operating Methods in the Douglas Fir Region", which was later (1936) followed by a bulletin on management by Kirkland and Brandstrom, entitled "Selective Timber Management in the Douglas Fir Region." Second, the Station, as well as the Regional Office, has cooperated directly with the West Fork Logging Company in the present logging demonstrations by assisting in the working out of financial marking rules and by establishing a large sample plot as was described in the monthly report for November 1937. Because of this cooperative work Brandstrom has made several trips to Mineral this summer and has kept in close contact with all developments.

Intermountain

Land Charge on Stock Ranch Operations. Field data are now being obtained for an analysis of the land charge on stock ranch operations in Region Four. Records are being obtained from the ranches that have a range survey on the deeded lands, either from the ACP range program, or some other phase of the Cooperative Western Range Survey. The record obtained from the ranches is designated to show -

- (1) the land charge in taxes and land investment values, per animal-month of capacity for range lands and hay lands,
- (2) the land charges per animal-month for the present rate of use of range lands, and
- (3) the present land charge for cattle and sheep for the entire year's operation, for the different types of ranch organization and land use.

FOREST AND RANGE INFLUENCES

WATER BEHAVIOR AND RUN-OFF

Appalachian

Analysis of Watershed Data. E. A. Brater, instructor of hydraulic engineering at the University of Michigan, spent part of the summer at the Appalachian Station on run-off studies from small drainage areas with Hursh, Hill, and MacKichan. Some significant results were obtained which will doubtless alter certain established conceptions of storm run-off.

Those familiar with the heavily forested lands of the Southern Appalachians have been amazed at the capacity of the soil for absorbing water. Many have expressed the opinion that the infiltration capacity of these soils is reached only by an occasional very localized cloudburst or after long continued storms. Because the visible overland flow seldom occurs on these watersheds, it has been suggested that the water may be flowing below the litter layer, either upon the B or C horizon. This may account for the

typical storm hydrographs produced on these streams by heavy rains.

A careful survey of the length of the flowing stream on a drainage area of 145 acres, Area No. 7 of the Ceweeta Experimental Forest, has produced some evidence which may add to our understanding of the hydrology of small forested drainages. The total length of the flowing stream during a heavy rain was found to be 11,110 feet. Computations were then made of the total volume of stormflow for 18 storms ranging in amounts from one inch to 5.94 inches. It was then determined how wide a strip, having for its center the center line of the stream, would be required to produce this total volume of stormflow, providing all the rain falling upon that strip ran off.

The results show that a strip varying in width from 6.1 to 16.8 feet, with an average width of 9.8 feet, is required to supply the total storm run-off. A strip 9.8 feet wide for 11,110 feet of flowing stream has an area of approximately 109,000 square feet, 1.7 percent of the total area of the drainage basin. Since the average width of the stream itself is 3.7 feet, the strip extended from 1.2 to 6.5 feet on either side of the stream. It is believed reasonable to assume that the major portion of rain falling so near the channel will quickly percolate into the flowing stream, especially since the soil near the stream banks is gravelly in nature. If it is possible to account for the major portion of the stormflow in this manner, it must be concluded that the infiltration capacity of these soils is greater than any rainfall intensities so far encountered. In fact, the results obtained in this study indicate that the stream hydrograph on well forested drainage areas is in reality direct channel or nearly direct channel interception and not, in the accepted sense, an expression of overland flow.

The significance of these results is apparent when one considers them in relation to the commonly accepted surface detention theory of surface run-off. The theory is that when rainfall excess occurs, that is, when the rate of rainfall exceeds the infiltration capacity, a film of water is built upon the surface which finally becomes thick enough to establish overland flow, in accordance with the principles of hydraulics. The current study raises serious questions concerning the validity of this method of accounting for the stormflow.

California

Kings River Watershed Studies: Big Creek Unit. The installation in this unit, representing the woodland-grass cover type, was completed in 1936, and since then two seasonal records of precipitation, run-off and erosion have been collected. The following table presents these data for Watershed No. 4, which received approximately the same heavy grazing use each season.

Season	Precipitation			Run-off		Erosion rate Cu.yds. sq. mi.
	Total inches	Heaviest storm Inches	Duration	Inches	Percent rainfall.	
1936-37	34.21	5.71	3 days	7.7	22	128
1937-38	42.20	12.44	3 days	14°	33°	12,000 ⁴⁰⁰

o Preliminary estimate, subject to revision.

oo Based on air-dry material collected in debris reservoirs and expanded to a square-mile basis for comparative purposes only.

It is worthy of note, however, that the heaviest storm recorded for each season produced the bulk of the erosion and that the erosion rate for the 1937-38 season was about 100 times that for the 1936-37 season. The latter fact is doubtless explained by the difference in volume and intensity of precipitation occurring during the major storm which amounted to over twice that of the previous season.

The above data have not been analyzed and general conclusions or expansion to other watersheds should not be attempted.

Teakettle Creek Unit. Construction of measuring devices and reservoirs in two of the three 500-acre watersheds, previously described, was resumed August 1. Additional construction will include the control of a 71-acre watershed, and 18 miles of trails, marked for winter identification.

Northeastern

Streamflow Recording Stations. Excellent progress was made during the summer in completing the several streamflow recording stations that the Civilian Conservation Corps are constructing for us. The dam and weir at the Chenango Experimental Forest was finished, but owing to the fact that the water-level recorder had to be sent to the manufacturer for adjustment it was not possible to obtain any measurements during the summer months. The recorder has been returned finally and will be installed shortly. The work on the dam construction at the Hopkins Experimental Forest has suffered seriously from the recent floods and high winds. The C.C.C. camp personnel has been greatly reduced by emergency conditions in Massachusetts. This fact, plus the danger of freezing weather, may make it impossible to complete the necessary concrete work this year.

Northern Rocky Mountain

Benton Creek. Construction was started, in late September, of a small streamflow measuring dam in Benton Creek, a mile from the Priest River headquarters to determine the run-off from this small drainage in which the precipitation is quite accurately determined. Snow courses at the headwaters and at the lower end, together with a chain of rain gages from creek mouth to the highest point in the drainage, have been operated for several years. The construction of weirs, operation of a stream level recorder, and the installation of two more recording precipitation gages, all on hand, are expected to contribute a little to our decidedly scanty knowledge of these conditions in northern Idaho.

A possibility exists for expanding this study to include an adjacent and similar drainage which could later be burned clean by fire behavior studies, the effects on run-off determined, and the area then replanted to great silvicultural advantage. At present the silvicultural conditions in the headwaters of the burnable creek are a problem which defied solution after recent examination by Koch, Bradner, Anderson, Wellner, Davis, and Gisborne. Whether or not such a combination of fire, influences, and silvicultural studies is worthwhile with these particular conditions remains to be determined.

Rocky Mountain

Watersheds Installations. Silt traps and run-off gages have been installed on six watersheds supporting young growth of ponderosa pine on granitic soil. These watersheds are all less than three acres in size and the installations will probably hold all run-off and erosion from any one storm. Safety factors are provided in case the installation does not have sufficient capacity.

Cover and Run-off. Run-off studies using artificial rain were completed during the summer on the short grass and mountain bunch grass types. Detailed studies of pore space of the soil, erosion pavement conditions, and soil profiles have been made in connection with the run-off studies. Preliminary analysis indicates that the soil factor is of considerably more importance in influencing run-off than vegetation.

Southern

Water Cycle Studies. Three 1/100-acre run-off plots have been established at Irons Fork on three types of land representative of those found in the lower foothills of the Ouachita Moun-

tain region. The plots are located on: (1) an over-grazed old field supporting a sparse grass cover, (2) a similar old field which has reverted to a shortleaf pine pole stand, and (3) uncleared forest land supporting an oak-hickory type. The plots are located on slopes averaging 10 percent and on soils identical excepting for past treatment. These plots are designed to provide data on surface run-off under foothill conditions, and the data will augment those being obtained from the 64 plots now in operation on the higher mountain slopes.

The first draft of a working plan has been drawn up by Collet for a study of forest litter in relation to rainfall interception. The plan calls for a survey to determine the kind and amounts of litter found in various Ouachita cover types and for detailed observations to ascertain the moisture-retaining capacity of typical types of litter.

Trial excavations were made on Irons Fork study areas to determine the feasibility of using soil-moisture sampling methods in studies of rainfall penetration. Considerable work has also been done by labor crews revetting and enlarging the stream channels at sites selected for gaping stations. The lack of funds continues to preclude the installation of permanent stream-gaging stations.

Southwestern

Oak Litter Retards Evaporation. The natural accumulation of oak litter under the evergreen oaks of the mountain brush type affords excellent soil protection. As the leaves and twigs of the oaks decay and are changed into humus, a spongy covering which gradually merges into rich organic soil material is formed.

Emory oak and Arizona white oak, the two most important species, shed their leaves in the spring just before new leaves make their appearance and the addition of litter from the trees offsets the disintegration which takes place below the leafy covering.

Three small lysimeters, consisting of blocks of undisturbed soil 16"x32 $\frac{1}{4}$ "x22" in depth placed in steel boxes equipped with facilities for measuring erosion, surface run-off, and percolation water have been installed in an opening located within the brush type near the Parker Creek Experiment Station. The surfaces and bottoms of these lysimeters are on a 25-percent slope and they are situated on a slope which faces northwest.

The lysimeters were taken from a diabase soil-type area where the subsoil consists of a yellowish-brown loam containing more sand than clay. One lysimeter has an undisturbed covering of litter and dark topsoil. The other two were taken from an opening where the

litter and much of the topsoil had been removed by accelerated erosion caused by disturbance.

Yield of percolation water over an 18-months' period was much greater from the litter-covered lysimeters, and surface run-off much less than from the bare lysimeters. Since the lysimeter blocks were taken from the ground during a dry period when the soil held only a small amount of moisture, subtraction of surface run-off plus percolation yield from total amount of water falling on lysimeters, as calculated from a U. S. Weather Bureau standard rain gage, gives a reasonably accurate measurement of water lost by evaporation. More water evaporates from the bare areas than from the lysimeter with undisturbed covering of litter, as shown in the following table.

Period -- October 1, 1936 - March 31, 1937

Lysimeter number	Precipitation inches (Snow and rain)	Surface run-off Inches	Percolation Inches	Evaporation inches
No. 1 - Bare		3.51	7.39	3.06
No. 2 - Bare		3.02	7.62	3.32
No. 3 - Litter covered	13.96	0.12	11.19	2.65

Period -- April 1, 1937 - September 30, 1937

No. 1 - Bare		2.18	0.09	4.89
No. 2 - Bare	7.16	2.11	0.11	4.94
No. 3 - Litter covered		1.82	1.08	4.26

Period - October 1, 1937 - March 31, 1938

No. 1 - Bare		2.64	4.70	4.24
No. 2 - Bare	11.58	2.58	4.52	4.48
No. 3 - Litter covered		0.52	7.03	4.03

Southwestern

Workman Creek Stream-Flow Stations Established: At the present time precipitation-run-off studies are being conducted at Parker Creek in two different types of country. Stream-flow stations have been established on the Sierra Ancha bench or lower region, which is characterized chiefly by chaparral

brush and grassland. The soil is stony and in many places the vegetative covering is sparse. A second set of installations is located toward the lower ends of the two principal canyons on the south slope of the main mountain mass. These canyons are steep-sided, troughlike drainages with a mixed vegetation verging from fairly densely covered brush slopes in the lower reaches to scattered timber toward the headwaters of the drainages.

The rainfall-run-off relationships in these two regions have already been observed to be very different and, to complete the full chain of sequence of water movement from mountain top to desert lake; it is essential to have a third set of installations in the upper or true timber type, which after all really forms by far the major portion of the yielding area. On the timber covered, cool, relatively broad tops, stream flow is generally perennial and the flow is much more sensitive to precipitation than at the lower altitudes. Drainage areas below this region might be looked upon as escarpment drainages only and therefore of no great importance so far as water yield is concerned.

This third and much needed set of installations has just been completed and placed in operation in upper Workman Creek. The contributing drainage basin is heavily timbered and stream flow is continuous throughout the year. The installations are as follows:

Three small dams or cut-off walls, one in each of the two branches -- the north fork and south fork -- and the third a short distance below the confluence in the main creek. The upper two dams carry 20-inch V-notch weirs, the maximum capacity of which is 8.58 cubic feet per second, and each is fitted with an 8-day water-stage recorder and vernier type hook gage. The lower or main dam has a 7-foot Cippoletti weir which will record up to 45 cubic feet per second and a 20-inch V-notch weir for measuring normal flows. There is a water-stage recorder for each weir.

In order to reduce the danger of freezing, 15 gallons of oil have been placed in the stilling wells at the upper dams and calcium chloride is to be tried at the lower installation, where also, through special structural arrangement, an effort has been made to reduce to a minimum all air movement through and across the stilling box of the V-notch weir. The flume, box, stilling well, and weir are completely housed in and it is hoped that it will be possible to thus heat the entire arrangement with a single, long-service lantern.

This third setup in the true timber type now completes the chain between mountain top and desert floor and makes it possible to study the relationship between precipitation and water yield in the three types of country which go to make up most southwestern

watersheds. There is also an opportunity to study the various losses to which water is subject as it moves from the regions of supply to the points of use.

SOIL STABILITY

Appalachian

Road Bank Fixation. Road bank fixation experiments begun in the spring of 1934 now offer an opportunity to compare different methods after five growing seasons. The results of these studies first reported in the Station's Technical Note No. 12, 1935, stress the importance of improving growing conditions on dry and infertile sites by the use of mulches either before any actual planting is done or at the time of planting. In comparison, a number of extensive projects were conducted by the use of direct planting without mulches. Results for three years are now available on a number of such projects. Successful results have been obtained in practically every case where mulch has been the principal method of road bank fixation and very irregular results have been obtained with direct planting. A comparison of available experimental plots and large-scale projects has been carried out and preliminary report prepared as Station Technical Note No. 31.

Rocky Mountain

Road Bank Fixation. Advice and guidance to the C.C.C. in road bank stabilization is being furnished by the station. This project is being handled on the Manitou Experimental Forest where three miles of newly constructed forest highway is being treated experimentally to demonstrate for the C.C.C. the most practicable methods. Measures being employed include drainage ditch paving and checking, drop inlet culvert, reseeding, wattling, and improved water disposal.

Southern

Road Bank Fixation. An inspection of the 244 plats comprising the second-year roadbank-fixation tests at Holly Springs indicates that the results obtained during the second year of the study will to a great extent confirm those obtained during the first year's trials. Sodding or the sowing of a seed mixture on

banks during the spring months has been shown to produce a far better cover than similar fall plantings. Virtually all seed mixtures sown in the fall have given very poor results, and although fall sodding eventually provides a cover the following year, the plants establish themselves much more slowly than when this work is done in the spring. The special method of slope preparation developed in this study continues to give much better results than the orthodox trenching method. The varicus types of protective cover that have been used, including cotton fabric, light brush and litter cover, and a winter cover crop, were again found to inhibit the growth of plants and to produce relatively inferior plant cover. It appears that these and similar types of cover should be left on banks only a few weeks after plant growth starts. Of the species used in seed-mixture trials, crabgrass has showed up best and has formed the dominant cover on virtually all plats sown to seed mixtures in which this species was represented. Crabgrass is an introduced annual which has become a weed throughout the Southern States and an obstacle to using it in roadbank-fixation work is the fact that seed can seldom be purchased and must be collected locally by laborious hand methods.

It is planned to employ several of the outstanding bank-fixation treatments on full-scale road projects next spring. One of these treatments was applied in June to one of a pair of roadbanks from which soil losses have been measured for over a year. The treatment consisted of planting Bermuda-grass sods 1 foot apart on a #1.5:1 slope over which a thin layer of fertilized topsoil had been applied. Fertilization was light and at the rate of about 1/2-pound per 100 square feet. This treatment formed a 100-percent cover on the bank in about 40 days. About 3 weeks after the bank was planted, it absorbed every drop of a moderate rain, whereas the run-off from the untreated bank amounted to more than 60 cubic feet.

Gully Control. During the summer, a working plan was prepared for a study to test out several devices that may prove useful as substitutes for check dams in gully-control work. The use of soil-collecting trenches or pits in place of check dams has already been tried out on a sufficient scale to indicate that these devices will provide suitable planting sites in certain types of gullies. Additional trials will be made to determine which type of trench can be constructed most economically and will undergo least erosion. Other devices that will be tested consist of several simple types of checks designed to stabilize the natural deposits of sand which accumulate on the bottom of so-called "sand gullies." These gullies, usually developed in loose, unconsolidated sandy materials, are difficult to control. When check dams are built they merely catch up the raw sands which otherwise would accumulate naturally in the gully channels. The natural sand deposits provide relatively good growing sites for pines and several other tree species, but they are usually only in an arrested state of transportation, and when they

are planted to trees there is no assurance that abnormal run-off may not sweep out the trees before they have gained a foothold. It appears that these deposits can be stabilized as planting sites without resorting to dams, and several simple types of log and brush structures will be employed in the study with this in view.

Special Problems. Progress was made at Irons Fork in analyzing special watershed-improvement problems and in formulating investigative plans for their solution. In this connection, the prevalence and extent of rock talus areas on many of the mountain watersheds under study apparently creates special problems in run-off control. These rock deposits cover extensive areas of certain upper-slope sites, and sometimes extend from points near the ridge divides to the stream channel. A survey of one such talus slope located in a watershed unit adjoining the Irons Fork drainages revealed that an area of 5 acres was covered with huge boulders to a depth of 24 feet. Explorations revealed that the talus was underlain by weathered mineral soil, showing that the rock was entirely overcast material. These talus areas appear to be heavy contributors to the peak flow of streams, inasmuch as they seemingly offer little obstruction to run-off and permit virtually all of the rainfall to sink through the rock mass and reach stream channels quickly via subsurface routes. Observations indicate that the water table is rather high in the underlying soil profile, and that these mineral soils remain rather moist and near field capacity. This situation no doubt contributes to excessive run-off from areas of talus and limits infiltration and storage of rainfall after it sinks through the rock overcast. Since the talus slopes support only a scattering of scrubby trees, and since the rock mantle offers considerable protection from sun and wind, soil moisture is probably subject to evapo-transpirational draft to only a minor degree. The improvement of forest cover on talus slopes would undoubtedly be a slow and dubious remedy. Likewise, on areas of this nature there are obstacles to employing effectively the various engineering techniques for retarding or storing run-off. Special remedies are being considered, however, and will be tried out on a small scale in the near future.

A tentative working plan has been drawn up to guide preliminary trials of several forest-engineering measures designed to reduce the peak discharge of the smaller streams draining the upper mountain slopes. The working plan contemplates the trial of several types of storage or diversion works, including (1) low impounding dams of earth or rock fill, (2) diversion-spreading works, and (3) water-storage trenches. A few of these trial structures will be constructed on a tributary unit of Rock Creek, and will be kept under observation during the coming rainy season, in order to gauge their retarding effect on storm run-off and probable contribution to the reduction of the peak flow of streams.

MICROCLIMATE

Rocky Mountain

Interception as influenced by various methods of cutting. Interception studies are in progress on 20 methods-of-cutting lodgepole pine plots on the Fraser Experimental Forest. These plots have not yet been cut over and while in a virgin condition detailed studies of snow and rain interception have begun. After a brief period of two or three years the plots will be cut over by various methods and the interception studies will be continued for a period sufficient to determine man's influence. The interception phases of this study are being handled by the forest influences project and silvicultural phases are being handled by the branch of forest management.

FLOOD CONTROL SURVEYS

Allegheny

Kiskiminitas and Lehigh Rivers. Reports of the preliminary examinations of the Kiskiminitas and Lehigh River watersheds in Pennsylvania were completed and forwarded to Washington.

Allegheny and Passaic Rivers. Preliminary examinations of the Allegheny River watershed in Pennsylvania and the Passaic River in New Jersey were begun, and considerable progress has been made on both.

Youghiogheny River. Following authorization by the Secretary of Agriculture, work was begun on a detailed survey of the Youghiogheny River watershed in Maryland and Pennsylvania.

Map Coloring. The desirability of color as an aid in clarifying descriptive features on maps has long been recognized, but although several methods for hand coloring of original maps have been perfected, mechanical duplication has not been practicable in anything short of expensive and elaborate processes. After some experimentation with the Standard Process Duplicating Machine, however, it was found that very satisfactory color reproduction was possible by the use of this machine, and, accordingly, copies of all maps used in the Lehigh watershed report were colored by this process. Color variety is restricted to purple, red, and green, but combinations of solid colors and various forms of cross-hatching and symbols may be used to extend the limits of differentiation.

In addition to the simplicity and economy of the process involved, the master map can be prepared quite readily and will yield from 100 to 150 satisfactory duplications.

Appalachian

Coosa River Drainage. Flood control survey work on the Coosa River drainage above Rome, Georgia, was started during September. This area contains approximately two and one-half million acres of as diversified land conditions as will be found in an area of this size.

One of the major problems of the Survey is the lack of data pertaining to the hydrology of the area, which must, in the last analysis, form the basis both for the evaluation of the benefits to be derived from remedial measures and for the justification of any flood control plan, be it a conservation program or an engineering procedure.

Central States

Preliminary Examinations: Green River. The greater part of early June was given to preparing the preliminary report on Green River, Kentucky, and Tennessee. This report was completed and sent to S.C.S. and B.A.E. for signature on June 25.

Mad River. The S. C. S. (Dayton office) completed the report of the preliminary examination of the Mad River, Ohio, and forwarded it to Washington.

Weldon River. Preliminary examination on Weldon River, Missouri, and Iowa, was signed and forwarded to B.A.E. for their signature on June 14.

White River. Initial work on the White River report (Arkansas - Missouri) was made.

Detailed Surveys: St. Francis and Muskingum Rivers. Practically all of July and August was given to development of procedures and organization of parties for the St. Francis River, Missouri and Muskingum River, Ohio watershed surveys.

To provide first hand contact with control measures used in Western localities, Knight made a trip to Utah and California in late June and early July. He not only observed the methods used to control slopes in Utah, but also gained valuable ideas on water control in southern California, the use of settling basins, subsurface storage, and engineering as well as watershed

cover devices needed and being tried out in that State.

On August 19 the headquarters of the Muskingum survey was established at the S.C.S. office, Mt. Vernon, Ohio. On August 30, the St. Francis Survey was initiated with D. Manley Knight as project leader with headquarters at Fredericktown, Missouri.

Infiltration Rates - St. Francis. A study of water infiltration rates was made in St. Francis County on three cover types - second-growth forest, brush, and open pasture located on five soil types. A highly significant difference was found between covers and between soils in their ability to absorb water. In percentage runoff, open fields were highest, brush next and second-growth forest least. Clarksville Stony and Clarksville Gravelly loams showed higher rates of run-off than did Tilsit and Hagerstown silt loams. Ashe silt loam was intermediate. In those conditions studied, the highest rate of run-off was found on upland pastures located on the Clarksville soil series.

Intermountain

Boise River. Aimed at remedying a serious flood-sedimentation-erosion problem on one of the most important drainage basins in the Intermountain Region, the Boise Flood Control Survey Project, is past the preliminary planning and organization stages and is now in nearly full operation out of field headquarters at Boise, Idaho. With eight Forest Service, three Soil Conservation Service, and one Bureau of Agricultural Economics men on the job, the project crew has for its immediate objective the preparation of recommendations for a control work program on one of several flood source areas by December 1, 1938 and the initiation of several special flood and sedimentation damage studies, the results of which are needed for reporting upon the entire watershed.

The Boise River watershed covers about 3,600 square miles of which about 25 percent includes the highly developed irrigation-agricultural area of Boise Valley while the remainder is steep, deeply dissected forest and range covered mountains largely within the Boise and Sawtooth National Forests. In recent years destructive floods have occurred over the farm lands along the main river channel in Boise Valley while the highly essential irrigation water supply has been reduced significantly by sedimentation in the reservoirs, diversion dams, and canal systems. Concurrently, the productivity of the forest and range lands has been seriously lessened by accelerated erosion.

An extensive reconnaissance over the entire watershed has been completed already. This revealed that the major flood and sedimentation source areas are mostly on the mountainous portion,

including four extensive, depleted, range areas, three large burns in ponderosa pine, two large and several small placer operation areas, while lesser but probably significant problem units include several logged areas, many miles of unstabilized road cuts and fills, and improperly cultivated farm lands. On the basis of this survey, a field crew is drawing up specifications for a program of run-off and waterflow retardation and erosion prevention on a seriously depleted range unit adjacent to the Arrowrock reservoir. Engineering crews are initiating studies of the silt load in tributaries above and below problem areas, and of sedimentation in the reservoirs, canals, and main river channels as a basis for planning control works on other units; while others on the project are assembling data on the damage, economic, and physiographic aspects of the flood problem.

The U. S. Corps of Engineers has not yet initiated a survey of the downstream phases of the flood problem, but preliminary arrangements have been made for coordinating the efforts of that agency with the work already undertaken by the FCS organization of the Department.

Lake States

Kickapoo and Saginaw Rivers. Preliminary examination reports have been completed for the Kickapoo watershed in southwestern Wisconsin and the Saginaw watershed in the lower peninsula of Michigan.

A detailed survey was recommended and approved for the Kickapoo River. A field office was established at Viroqua, Wisconsin, and the detailed survey commenced during September. Unfortunately aerial photographs are available for only a small portion of the watershed. A fairly good sample of conditions will be obtained, however, by using the individual farm maps prepared by the Soil Conservation Service camps of various farms scattered throughout the area. Later, additional farms will be examined to strengthen the original sample where necessary.

Northeastern

Merrimack River. On August 22 work was started on a detailed survey of the Merrimack watershed to determine the economic feasibility of a flood control program in the headwaters areas. In this survey the Department is investigating the need for improved farm and forest land management, the control of stream bank erosion through vegetative and other means, flood water detention storage in small ponds, as well as some other less important phases of headwater development for the retardation of flood run-

off and the prevention of erosion.

If the survey develops some feasible projects, detailed plans will be prepared for some typical examples so that work can be initiated as soon as money is available for the purpose.

Northern Rocky Mountain

Columbia, Colville, and Kootenai Rivers. Inability to locate a qualified man to head up the flood control surveys at this Station has somewhat delayed the work of preliminary surveys on the several watersheds authorized for examination in the Upper Columbia River drainage. Bradner, as chairman of committee 23-A, represented the Department of Agriculture at joint public hearings on the Colville River (Washington) on September 13 and on the Kootenai River (Idaho) on September 20. Several meetings with the work members of committee 23-A were held and some public relations work done in the two watersheds prior to the meetings. The official Bureau of Agricultural Economics member of committee 23-A is stationed at Berkeley, California, and has not yet been able to visit this region.

Pacific Northwest

Chehalis, Skagit, Nooksack, Tanana, John Day, and Cedar Rivers, Lowell Creek, and Chena Slough. The preliminary flood control reports for the Chehalis and Skagit River watersheds were completed during the summer and have been submitted to Washington. The report on the Nooksack River is now being edited and put in final form. Reports have been prepared for two Alaska streams, Lowell Creek and Tanana River and Chena Slough. Mr. Rockie of the Soil Conservation Service spent several weeks in Alaska this summer and these reports were sent to him for checking and such additional information as he might be able to obtain. Very little work remains to be done on these two reports and it is hoped to complete them by November. The first rough draft of the Forest Service section has been completed for the John Day and Cedar River reports.

On August 26 a meeting of Field Coordinating Committees 21 and 22 was held in this office to discuss the priority of reports, allotment estimates for a detailed survey of the Willamette and John Day Rivers, and a means of coordinating the work of the three bureaus to promote more efficient organization. The watershed priorities and allotment estimates agreed upon were sent to Washington shortly after the conference.

Willapa and Naselle Rivers. On September 8 a joint hearing upon the Willapa and Naselle Rivers was held at Raymond, Wash-

ton, by the Departments of War and Agriculture. Bolles represented the Station at this hearing.

Rocky Mountain

Powder, Big Horn, North Platte, Fountain, and Washita Rivers, and Bear Creek. Preliminary examinations have been completed by this station for the Powder, Big Horn, and North Platte Rivers, and at present a field party is at work on the Yellowstone River. Detailed surveys in which this station is participating are in progress on the Fountain River in Colorado and the Washita River in Oklahoma. In addition, general information is being accumulated currently on all floods occurring in the region and a request has been made for approval of a detailed survey of Bear Creek which caused considerable flood damage near Denver early in September.

Southern

Trinity, Tallahatchie, Colorado, and Red Rivers. During the summer months, activities under this project centered around the initiation of detailed surveys of Trinity River, Tex., and of the Little Tallahatchie River in northern Mississippi. The Trinity survey, with headquarters at Fort Worth, is under the chairmanship of the Soil Conservation Service, whereas the Station has primary responsibility for the Little Tallahatchie project. Work on preliminary examinations has been brought to a virtual standstill owing to the urgency of getting surveys started. However, Turner collaborated with the SCS Fort Worth office in preparing a preliminary examination report for Colorado River, Tex., and in getting together additional material for preliminary reports of the Arkansas and Red River drainage basins.

Southwestern

All authorized flood control work is now being actively prosecuted by the Soil Conservation Service, Bureau of Agricultural Economics, and Southwestern Station, with the status of the work to date as follows: Preliminary examinations made and reports submitted:

Upper Gila River, Arizona and New Mexico

Upper and Lower Santa Cruz River and Sabino Canyon, Arizona

Queen Creek, Arizona

Hassayampa River, Arizona

Preliminary examinations completed and reports in preparation:

Bill Williams River, Arizona

Big Sandy River, Arizona

Major Long's Creek, New Mexico and Texas

Wolf Creek, Texas

Preliminary examinations in progress:

Little Colorado, Arizona and New Mexico

Surveys completed and reports in preparation:

Queen Creek, Arizona

Surveys initiated:

Upper Gila, Arizona and New Mexico

The Regional Conservators of the Soil Conservation Service are Chairmen of the above watersheds; Region 6 at Amarillo for Major Long's and Wolf Creek projects, Region 8 at Albuquerque for the balance.

COOPERATING BUREAU PROJECTS

BIOLOGY

(In Cooperation with the Bureau of Biological Survey)

Northeastern

Relation of small mammals to Northeastern spruce type soils. An investigation was begun in September with the trapping of areas surrounding Dr. Jacot's 15-soil sample sites at the Gale River Experimental Forest (White Mountains), to determine which species are present and their relative abundance. Check lines were run in nearest adjacent types to each sample. The catch data are being analyzed for significance in variations. Outstanding results of the trapping were the absence of the short-tailed shrew (Blarina) and the great abundance of red-backed mice (Evotomys). Plans are being made for quantitative trapping next season to determine populations on a per acre basis.

ENTOMOLOGY

(In Cooperation with the Bureau
of Entomology & Plant Quarantine)

Appalachian

Southern Pine Beetle. During September a cut of approximately four million feet of beetle-killed loblolly pine on a heavily infested tract near Como, North Carolina, was completed. This operation, including the burning of infested bark at the mill and the spraying of infested tops left in the woods, very probably contributed to the great decrease in southern pine beetle broods in that area. However, there was a very definite decline in beetle numbers in other heavily infested areas in the vicinity of the Como tract, attributable entirely to natural factors - rainfall and predators. Surveys elsewhere in the eastern part of the Atlantic States indicated very little southern pine beetle activity.

White Grubs. Very serious damage by white grubs was reported from the State Nurseries at Georgetown and Camden, South Carolina. This was not surprising as both nurseries suffered similarly in years past, and many beetles were found during the nightly collections made earlier in the summer. Larvae hatching from eggs laid in the seedbeds by these beetles during the current flight period caused most of the damage.

Insect Damage to Red Cedar Seedlings. June examinations of the red cedar seed beds in the nursery of the Bureau of Agricultural Economics near Lebanon, Tennessee, earlier infested with the seed-corn maggot, showed the seedlings in far better condition than during the same period in 1937. This is attributable primarily to watering this year during the dry periods. Tests to control the maggots with an emulsion of carbon disulphide gave promising results.

Chemical Absorption and Distribution in Posts and Trees. Tests of capping and stepping shortleaf pine and yellow poplar trees and posts of various lengths with different concentrations of zinc chloride and copper sulphate solutions were made to determine absorption and distribution, and to test the resistance of the different treatments to attacks and damage by termites and other wood-destroying insects.

Numerous yellow poplars and shortleaf pines were injected with chemicals by banding to test primarily the bark-holding properties of the different chemicals when logs from the treated trees are kept relatively dry under a roof. These sections will be used

for comparison with standing and felled trees treated at different seasons each year from 1930 to 1937.

Studies of Powder-post Beetles and Hickory Seasoning.

Samples of hickories cut in April 1937 and each month thereafter and subjected to various methods of seasoning and drying, were exposed to powder-post beetle infestation. Each sample used had been examined for starch content at the time the tree was felled and regularly each following month to determine its change in starch content.

Duplicate samples of most of these hickories were continued under the seasoning or drying procedure, while additional trees were felled, sampled, and subjected to methods of seasoning or drying for infestation tests next year.

Central States

Walnut Datana. This year has been a very severe one for black walnut in central Ohio because of serious attacks by the walnut datana. Very few trees have escaped partial to complete defoliation but no instances of more than one generation were observed. Many trees produced a partial secondary crown of smaller leaves, which are bright green, contrasting strongly with any older olive green foliage which was not taken by the caterpillars. On unattacked walnut trees leaves were falling quite noticeably during the last ten days of August, although this has been a well-watered and moderately temperatured summer.

Catalpa Sphinx Moth. Similarly, this summer has seen almost complete defoliation of catalpa trees (singly and in groves) by the catalpa sphinx moth in central Ohio. In some instances the caterpillars have been heavily infested by parasites as evidenced by the white rice-like pupal cases attached to the skins of many larvae.

Nantucket Tip Moth. Reports are continually being received concerning the increasing seriousness of this pest on short leaf pine. The S.C.S. reports attacks on both short leaf and pitch on its plantations in Kentucky and Tennessee. Day reports a 15 percent infestation on planted short leaf on portions of the Gardner Purchase Unit. No native pine being infested it is evident that the insect is coming from the Licking Nursery.

Locust Borer. On September 21, Dr. Harvey MacAloney together with W. L. Baker and Herbert Secrest visited the Station while on inspection and remeasurement work on the Locust Borer Investigation.

Southern

Forest Tree Insects: Barkbeetles. H. R. Johnston, with a representative of the State Forester's Office of Mississippi and a ranger from the Sumpter Lumber Co., made an inspection of bark-beetle infestation in pine timber at Electric Mills, Mississippi. Normal endemic infestation by Ips was found in case of a few trees near pines that had been struck by lightning. Similar infestations have been reported from northern Florida and handled by correspondence.

Pine Colaspis. This beetle (*Colaspis pini* Barber) continued to brown the needles of young pine trees by feeding on the edges of the needles in southern Louisiana and Mississippi from June through September. It annually causes fear by timber owners that the trees are being killed, whereas all signs of injury soon disappear.

Tip Moth. Four experimental chemical sprayings have been made this year in the experimental plantings on the Kisatchie National Forest; as yet there is very little infestation by the tip moth.

Nursery Insects: White Grubs. Since being transferred to this station in May 1938, Johnston has spent considerable time revising several manuscripts on white grubs.

Johnston attended the conference of nursery officials at Albany, Georgia and Olustee, Florida; and delivered an address on insect pests of forest nurseries in the Gulf States. Defoliation was reported by blister beetles of young black locust seedlings in a nursery in Arkansas, and is another case of an insect normally injurious to crops and ornamental plants becoming a pest in forest nurseries. There has been no damage by white grubs this year at the nurseries at Albany or Olustee.

Forest Products Insects: Termites. Many houses infested with termites were inspected in July and August and the owners' consents to experimental treating were obtained, where they were suitable for the test, as part of the soil poisoning project; seven of these houses were treated in September with 2 different chemicals (chlorinated phenols).

In August, the Monsanto Chemical Co. installed a series of soil poison tests to protect approximately 600 stakes against termites on the Harrison Experimental Forest near Saucier, Mississippi.

Powder-post Beetles. At Tallulah, Louisiana, 77 chemical dips for boards and 21 chemical sprays for piled lumber are under test as methods of protecting hardwood lumber against powder-

post beetles. Snyder inspected the work at Tallulah and additional work was outlined for Christian. Additional tests are continually being installed, especially some for the Union Fork and Hoe Company, of Jackson, Mississippi.

Ambrosia Beetles. Sixty-six chemical dips and 9 chemical sprays for green lumber were tested at Tallulah in an effort to protect such lumber from attacks by ambrosia beetles; all of the dips have failed, some of the sprays show promise. Data were obtained on the moisture content of lumber after various stages in seasoning, especially in end racking, and just what moisture contents were most favorable and unfavorable to attack by ambrosia beetles; end racking for 12 to 15 days will reduce the moisture content to a point where the beetles will not attack; this may be as high as 45 to 52 percent; there is no warping, even in gum, up to 15 days.

FOREST PATHOLOGY

(In cooperation with the Bureau of Plant Industry)

Appalachian

Decay Following Fire. More than 900 fire-scarred trees of yellow poplar, basswood, and 6 species of oaks, have been examined during the summer to determine the volume of cull that developed from the wounds. These data will be analyzed in an attempt to develop a mechanism for predicting cull from fire wounds. The work was conducted on 8 commercial logging operations in the mountains from Virginia to Georgia. This project is cooperative between the Experiment Station and the Division of Forest Pathology.

Hemlock Twig Rust. An investigation of the life history and control of this disease brought out that infection by the fungus Melampsora farlowii takes place in the new hemlock foliage between the time the buds burst and the middle of June. The sources of inoculum are the overwintered telia in the twigs killed the preceding year. Effective control was obtained by spraying with lime-sulfur once a week during May.

Mimosa Wilt. Many new infections of the disease were found in the Carolinas this summer.

Southern

Native Canker-Forming Rusts: Plantation Survey. Extensive surveys were made in the Gulf States to determine the seriousness and extent of canker-forming rusts in loblolly and slash pine plantations. Plantations with the greatest amount of infection occur largely in the southeastern sections of Louisiana and Mississippi. In southern Georgia and in Alabama, where slash pine has been widely planted on longleaf pine sites, less intense outbreaks of the disease were discovered. In Florida the rusts have not generally caused serious damage in plantations. A brief survey by Lorenz in southeastern Arkansas indicated no outstanding case of infection; shortleaf pine was seldom attacked and loblolly pine was as usual the more susceptible to infection.

Pruning of Cankers. Pruning of cankered lateral branches, particularly in young, severely infected plantations, has been suggested and approved as a useful activity for C.C.C. enrollees. This is a measure designed to reduce the losses caused by the rust during the first 3 to 5 years in the life of the stand. The pruning of cankered branches in young slash pine plantations has been started in Region 8 on the Leaf River District of the DeSoto National Forest.

Nursery Infection and Control Measures. A survey conducted by Lamb and Sleeth in 15 nurseries in Louisiana, Mississippi, Alabama, Georgia, and Florida revealed infections ranging from 0 to 27 percent per nursery. The weighted average loss due to the disease in this year's growing stock was 5.4 percent for slash pine and 4.3 percent for loblolly pine.

Plans were made for controlling canker-forming rusts in the Ashe Nursery in 1939. The program, now approved as a cooperative project between the Forest Service and the Bureau of Plant Industry, includes spray treatments, oak eradication, varying the time of watering and planting, and studies of meteorological conditions and telial production. C.C.C. enrollees will be used in a good share of this work.

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